Environmental Policy Tools: A User's Guide

September 1995

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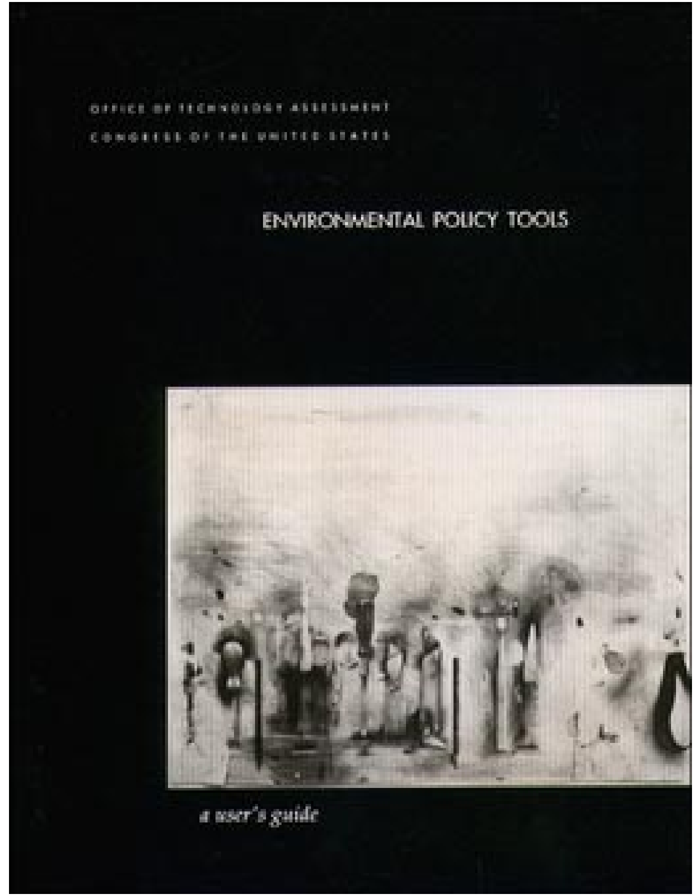

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Foreword

Concerns over the costs of pollution control and the persistence of some pollution problems have fueled criticism of how the nation is pursuing its environmental protection goals. In particular, interest in policy instruments that utilize or improve market forces, while not new, has grown considerably over the past decade. Yet this interest continues to be met with confusion—and sometimes unrealistic expectations—about what these approaches can accomplish in some instances, and with suspicion over whether they can offer meaningful protection. The Senate Committee on Environment and Public Works asked the Office of Technology Assessment (OTA) to help Congress sort out the often conflicting claims about the effectiveness of major policy instruments.

The assessment looks at a range of regulatory and nonregulatory instruments, both the old standbys and less commonly used approaches. The "ideal" instrument would move the nation toward a cleaner environment, be as cost-effective and fair as possible, and accommodate increasingly rapid changes in science and technology. Finding an instrument to satisfy all of these objectives at once has seldom proved possible in the past—and may be even more difficult in the future. But whether Congress prefers to specify the choice of policy tool itself or delegate the choice to states, localities, or the Environmental Protection Agency (EPA), someone is faced with the difficult problem of matching tools to problems.

This "user's guide" presents a framework to help decisionmakers narrow down the choice of instruments for addressing a particular problem. First, the report describes 12 policy tools, and how and where they are currently used. Based on state, federal, and international experience as well as theoretical literature, OTA rates the relative effectiveness of these tools in achieving each of seven criteria often considered in environmental policymaking. Given a decisionmaker's preferences among the criteria and the characteristics of a particular problem, this framework draws attention to those instruments that might be particularly effective—or used with caution.

OTA appreciates the generous assistance of the project advisory panelists, reviewers, contractors, and other individuals who contributed ideas and information for this study. Their suggestions and advice were extremely valuable.

ROGER C. HERDMAN
Director

ERRATA --- ADVISORY PANEL
FOR
Environmental Policy Tools: A User's Guide

In the printing of this report, OTA inadvertently omitted the page listing the Advisory Panel to the study. OTA deeply regrets this error and apologizes to the individuals who gave such valuable service during the course of the project. As with all OTA projects, the Advisory Panel does not necessarily approve, disapprove, or endorse the report. OTA assumes full responsibility for the content and accuracy of all its reports. We do, however, appreciate the thoughtful comments and suggestions of the Panel.

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Note: OTA appreciates and is grateful for the valuable assistance and thoughtful critiques provided by the reviewers. The reviewers do not, however, necessarily approve, disapprove, or endorse this report. OTA assumes full responsibility for the report and the accuracy of its contents.

Abbreviations

AQMP	Air Quality Management Plan
BACT	Best Available Control Technology
BADCT	Best Available Demonstrated Control Technology
BAT	Best Available Technology (Economically Achievable)
BCT	Best Conventional Technology
BDAT	Best Demonstrated Available Technology
BMPs	Best Management Practices
BOD	Biochemical Oxygen Demand
CAA	Clean Air Act
CARB	California Air Resources Board
CCAA	California Clean Air Act
CEMS	Continuous Emission Monitoring Systems
CERCLA	Comprehensive Environmental Response, Compensation and Liability Act (also known as "Superfund")
CFCs	Chlorofluorocarbons
CWA	Clean Water Act
DEP	(Massachusetts) Department of Environmental Protection
DEPE	(New Jersey) Department of Environmental Protection and Energy
DEQ	(Oregon) Department of Environmental Quality
EG&S	Environmental Goods and Services (Industry)
EPA	Environmental Protection Agency
EPCRA	Emergency Planning and Community-Right-To-Know Act
FIFRA	Federal Insecticide, Fungicide, and Rodenticide Act
HAPs	Hazardous Air Pollutants
LAER	Lowest Achievable Emissions Rate
MACT	Maximum Achievable Control Technology
MassOTA	Massachusetts Office of Technical Assistance
NAAQS	National Ambient Air Quality Standards
NEPP	Netherlands' National Environmental Policy Plan
NOEL	No Observable Effect Level
NO_x	Nitrogen Oxides
NPDES	National Pollutant Discharge Elimination System
NPO	Nonproduct Output
NSPS	New Source Performance Standards
OECD	Organisation for Economic Cooperation and Development
OPA	Oil Pollution Act
OPP	(New Jersey) Office of Pollution Prevention
POTWs	Publicly Owned Treatment Works
PPIS	Pollution Prevention Incentives for States
R&D	Research and Development
RACM	Reasonably Available Control Measures
RACT	Reasonably Available Control Technology
RCRA	Resource Conservation and Recovery Act
RECLAIM	Regional Clean Air Incentives Market
RTCs	Regional Trading Credits
RTUs	Remote Terminal Units
SAB	(EPA) Science Advisory Board
SCAQMD	South Coast Air Quality Management District
SIC	Standard Industrial Code
SIP	State Implementation Plan
SO_2	Sulfur Dioxide
SRF	State Revolving Loan Fund
TRI	Toxics Release Inventory
TSCA	Toxic Substances Control Act
TURA	(Massachusetts) Toxics Use Reduction Act
TURI	(Massachusetts) Toxics Use Reduction Institute
USGS	U.S. Geological Survey
VOCs	Volatile Organic Compounds

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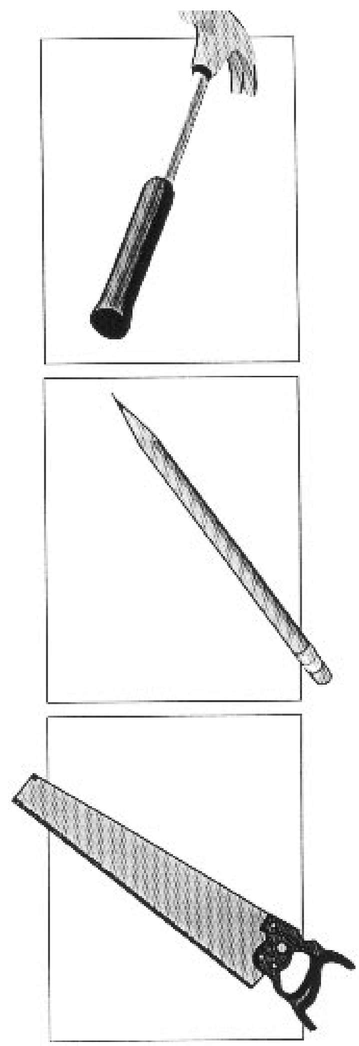
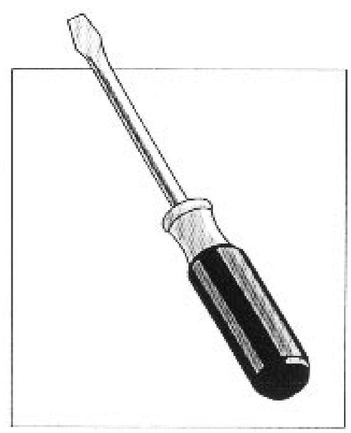


Executive Summary

The search for "smarter" ways to prevent or control pollution has generated heated debate on almost every conceivable topic related to setting goals, improving institutional arrangements, and choosing the most effective means for achieving those goals.

This last issue—**choosing the means or policy instruments to meet environmental goals**—can be a surprisingly complex task for decisionmakers, given the need to balance other competing concerns. The environmental policy toolbox contains many and varied instruments but lacks a clear set of instructions for their use. This OTA report fills that need. The "guide" is organized into three major sections:

- ***The Environmental Policy Toolbox:*** a discussion of 12 major policy tools, their frequency of use, and key strengths and weaknesses.
- ***The Criteria for Comparing Tools:*** our evaluation of how effective these instruments are in achieving the values and interests—or **criteria**—decisionmakers are likely to weigh.
- ***Choosing Tools:*** a series of questions for matching a tool or tools to a specific problem. Choosing tools that satisfy several, much less all, of these criteria for a specific problem is the challenge. **Unfortunately, no perfect policy tool exists to meet everyone's expectations for every problem.**



THE ENVIRONMENTAL POLICY TOOLBOX

Environmental goals related to pollution reduction can be reached in many ways. Some ways are quite prescriptive, others are not. If one imagines a factory having one or more pollution sources, it is easier to think of the many options available to Congress, the Environmental Protection Agency (EPA), and the states. Raw materials and products go into the factory, products are made, and quite often pollution is generated and released to the air or water, or shipped offsite for disposal, treatment, or storage.

To lower the pollution reaching the environment, government has many options. It can, for example: specify the end result—the amount of pollution that each source in the facility is allowed to discharge; specify what each source is to do to achieve the end result; charge a fee on pollutant emissions to discourage releases to the environment; or require nothing in particular but hold the facility liable for any resulting damages.

These are a few examples of how government encourages or forces potential pollution sources to achieve society's environmental goal and are among the 12 policy "instruments" or tools considered in this OTA report. Table 1 organizes the 12 tools according to whether or not they set specific pollution reduction targets.

The tools that set specific pollution reduction targets vary in the extent to which they specify *how* regulated entities must comply. *Single-source tools* require the sources themselves to comply with an emissions limitation or face associated civil or criminal penalties. These tools are often called "traditional" approaches because historically they are the most heavily used category of tools, or "command-and-control" because they can be less flexible than multisource tools. Single-source tools include harm-based standards, design standards, technology specifications, and product bans or limitations.

Multisource tools allow a regulated entity additional flexibility in how it complies with specific pollution reduction targets. A facility can change its own behavior to fit within the emissions limits, or can make an arrangement with another entity for it to comply with the limitation on the facility's behalf. Multisource tools include tradeable emissions, challenge regulation, and integrated permitting.

A second major category of tools encourages pollution prevention and control without setting specific pollution reduction targets. Technical assistance and subsidies make it easier or less expensive to do the environmental "right thing" by providing knowledge or financial assistance. Other tools, such as pollution charges, liability, and information programs, raise the financial stakes of continuing to behave in environmentally harmful ways.

Over the past 25 years, Congress has relied most heavily on single-source tools with fixed pollution reduction targets. Of the 30 major pollution control programs established under the Clean Air Act, Clean Water Act, and the Resource Conservation and Recovery Act, about four out of five use design standards and half use harm-based standards, typically in combination with design standards. However, many of the other tools in the policy toolbox have also been used, with increasing frequency as Congress has considered important competing objectives. (See figure 1.) Technical assistance, information reporting, liability, and tradeable emissions are each used in five to 10 of these major programs. Tradeable emissions, for example, evolved from an academic concept two decades ago to become a significant component of the Clean Air Act.

CHOOSING TOOLS

Whether Congress prefers to specify the choice of policy tools itself or delegate the choice to EPA, states or localities, or even the private sector, someone is faced with the difficult problem of matching tools to problems. An ideal environmental policy instrument would:

- be **cost-effective and fair**,
- place the least **demands on government**,
- provide **assurance** to the public that environmental goals will be met,
- use **pollution prevention** when possible,
- consider **environmental equity and justice** issues,
- be **adaptable** to change, and
- encourage **technology innovation and diffusion**.

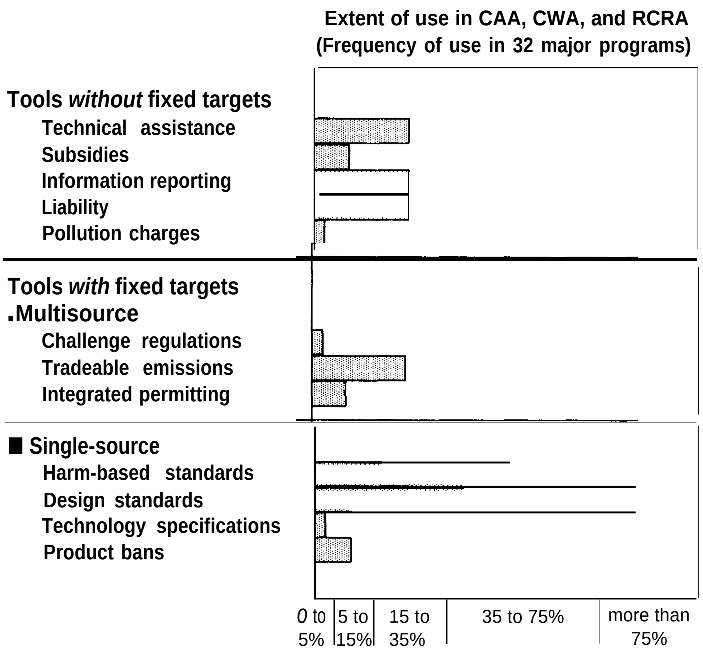
However, satisfying all seven of these criteria has seldom been possible in the past—and may be even more difficult in the future.

TABLE 1: Brief Definitions of Environmental Policy Tools

rsTools That Directly Limit Pollution				Tools That Do Not Directly Limit Pollution	
Single-Source Tools		Multisource Tools			
Harm-Based Standards	Describe required end results, leaving regulated entities free to choose compliance methods.	**Integrated Permitting**	Incorporates multiple requirements into a single permit, rather than having a permit for each individual emissions source at a facility.	**Pollution Charges**	Require regulated entity to pay fixed dollar amount for each unit of pollution emitted or disposed; no ceiling on emissions.
Design Standards	Describe required emissions limits based on what a model technology might achieve; sources use the model technology or demonstrate that another approach achieves equivalent results.	**Trackable Emissions**	Allow regulated entities to trade emission control responsibilities among themselves, provided the aggregate regulatory cap on emissions is met.	**Liability**	Requires entities causing pollution that adversely affects others to compensate those harmed to the extent of the damage.
Technology Specifications	Specify the technology or technique a source must use to control its pollution.	**Challenge Regulations**	Give target group of sources responsibility for designing and implementing a program to achieve a target goal, with a government-imposed program or sanction if goal is unmet by the deadline.	**Information Reporting**	Requires entities to report publicly emissions or product information.
Product Bans and Limitations	Ban or restrict manufacture, distribution, use or disposal of products that present unreasonable risks.			**Subsidies**	Provide financial assistance to entities, either from government or private organizations.
				Technical Assistance	Provides additional knowledge to entities regarding consequences of their actions, and what techniques or tools reduce those consequences.

SOURCE: Office of Technology Assessment, 1995.

FIGURE 1: Policy Tools Used in the Clean Air Act, Clean Water Act, and the Resource Conservation and Recovery Act



SOURCE: Office of Technology Assessment, 1995.

We present a two-part framework that helps policymakers first narrow down the choice of instruments based on how they perform on each of the seven criteria presented previously and then, if needed, helps them buttress weaknesses of any single tool by using more than one instrument.

Table 2 summarizes OTA's judgments about how well each instrument addresses each of the seven criteria. The purpose of making these judgments is to draw the decisionmaker's attention to those instruments which might be particularly effective or warrant a degree of caution in some instances. Strengths and weaknesses of a particular policy tool, however, can be determined with confidence only in the context of a particular environmental problem.

A series of key questions about the particular problem can provide answers which may point—in combination with the important criteria—to one set of instruments rather than another. First one must ask, ***Is there a reason to specify a fixed environmental target for this pollutant? Do the*** quantities and location of a pollutant, or the characteristics of its sources, provide a reason to prefer a fixed control target? To answer this, one needs to know how harmful or risky the pollutant is in the quantities that are being released. The more serious the problem, the more heavily one weights "assurance of meeting goals." The first column to the left on table 2 displays OTA's judgments of the assurance provided by each of the instruments.

Not at all surprising, those tools without fixed targets, are marked with a caution. One cannot say that goals will not be met—there are certainly instances when these instruments have been quite effective in the past. However, there is increased uncertainty that environmental goals will be met if tools without fixed targets are used alone.

If one prefers a fixed environmental target, the next question to ask is, ***Does this target need to be source-specific?*** Some environmental problems are regional in nature—for example, urban ozone

TABLE 2: Narrowing the Choice of Policy Instruments

	Environmental Results			Costs and Burdens		Change	
	Assurance of meeting goals	Pollution prevention	equity and justice	Cost-effectiveness and fairness	Demands on government	Adaptability	Technology innovation and diffusion
Tools *without* fixed targets							
Technical assistance		∇	●	O	•	●	•
Subsidies		∇	•	•	∇	•	•
Information reporting		∇	•	O	●	●	•
Liability	•	O	*	•	•	●	[illegible]
Pollution charges	•	•	∇	•	•	•	●
Tools *with* fixed targets—multisource							
Challenge regulations	•	•	•	O	O	0	0
Tradeable emissions		O	•	●	[illegible]	•	0
Integrated permitting	●	•	•	•	[illegible]	•	•
Tools *with* fixed targets—single-source							
Harm-based standards	●		•	•	∇		•
Design standards	●	o	.	•	•	-	-
Technology specifications	●	●	O	•	∇	•	
Product bans	●	0*		•	∇	•	∇

● = Effective O = It depends V = Use with caution . = Average

NOTE: These ratings are OTA's judgments, based on theoretical literature and reports of instrument use. The evaluation of each instrument on a particular criterion is relative to all other instruments. Thus, by definition most instruments are "average. " "Effective" means that the instrument is typically a reliable choice for achieving the criterion. "It depends" means that it maybe effective or about average, depending on the particular situation, but it is not likely to be a poor choice. And "use with caution" means that the instrument should be used carefully if the criterion is of particular concern

SOURCE: Office of Technology Assessment, 1995.

and acid rain-and thus can be successfully addressed by regulatory programs that incorporate marketable emissions or another multisource tool. For those problems that are local in nature, such as exposures to some toxic air pollutants, many will judge multisource instruments to be inappropriate. Similarly, the more difficult it is to monitor sources, the harder it is to use multisource tools.

The desire to allow sources to retain as much autonomy as possible leads one to instruments with no fixed target-those higher up in table 2. The desire for greater assurance pushes one further down toward instruments placing direct limits on pollution. However, many other concerns complicate the decision. Foremost among these is: ***Will costs and burdens to industry and government be acceptable?***

Increased autonomy to sources often can improve the cost-effectiveness and fairness of pollution prevention or control. However, government burdens might increase along with source flexibility if increased oversight appears necessary to keep the same level of assurance that goals will be met. We highlight several questions that help assess the overall costs and burdens in the context of a specific pollution problem. Some questions focus on the nature of targeted sources, including: are there large differences in control costs among sources? Are there either very many sources or very few? Other questions consider our knowledge basis, asking: Do we know how to set environmental targets, how to control the problem, or what it would cost to control?

Government burdens are affected greatly by available knowledge and the complexity of required analytical tasks. For example, a potentially risky pollutant that one might otherwise wish to control with a harm-based standard may be so poorly understood that a different choice might be necessary. Identifying available methods of control under a design standard poses fewer analytical difficulties than determining acceptable pollutant concentrations under a harm-based standard, though a design standard might require a less-than-ideal level of pollution control. Such trade-offs are not theoretical; Congress changed the harm-based approach to air toxics to a design standard in the 1990 Clean Air Act Amendments, because the harm-based approach had proven virtually impossible to implement.

There is one more related concern that may alter one's choice of instrument. ***Given the pollutant and its sources, do we anticipate or hope that tomorrow's understanding of this problem or its solution will be significantly different than today's?***

If the uncertainty about the nature of the risk is relatively high or if technology is changing rapidly, one might be drawn to those instruments that are most adaptable to change. Technical assistance programs, information reporting, and liability usually allow sources to make changes without government approval, and can be relatively easily modified by government when the need arises.

If, for a particular problem, Congress' environmental goals just cannot be achieved with today's technology at an acceptable cost, one might choose those instruments that spur technology innovation. Pollution charges can be effective because of the continuing pressure they exert. Product bans also spur innovation, but are typically avoided unless the risks from the pollutant are quite high. .Multisource instruments, such as tradeable emissions or challenge regulations, offer sources additional flexibility for using new technologies and thus may also help.

Throughout the research on this report, we identified a series of stumbling blocks that limit the use of potentially desirable tools. These stumbling blocks are at least part of the reason why, to date, the nation has primarily relied on a small subset of the available tools. Though many in Congress would prefer a more risk-based approach to environmental regulation, the poor understanding of risk makes this difficult at this time. Similarly, both government and industry recognize the advantages of performance-based approaches, but the lack of monitoring technology often stands in the way. Finally, the limited experience with some policy tools at times becomes the reason for staying with well-tried, though imperfect, methods. This report includes a series of possible actions to help remove each of these three stumbling blocks.

Summary | 1

Over the past 25 years, environmental protection has been a major issue on the nation's policy agenda, resulting in significant increases in the scope and number of environmental regulations. While these regulations have undoubtedly resulted in broad societal benefits, they have also provoked contentious debates. These controversies have recently intensified, and the list of perceived problems has expanded to cover everything from the environmental goals themselves to the strategies and costs of achieving them.

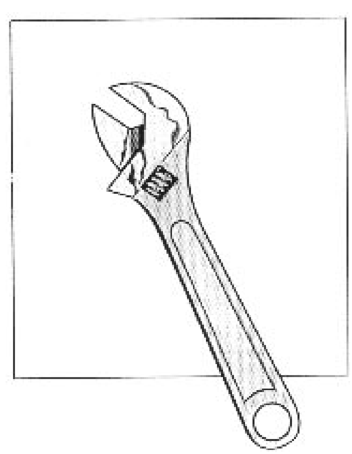
The search for "smarter" ways to pursue environmental protection policies has typically focused on one or more of the following three issues:

Goals: What are the most serious risks to public health and the environment, based on sound scientific evidence and public values, so that goals can be set accordingly?

Institutions: What improvements can be made in institutional arrangements and working relationships among stakeholders in the environmental policy community (including federal, state, and local governments, businesses and industries, and the public) to provide more effective policies for environmental protection?

Tools: Once specific goals have been established, which policy instruments will be the most effective in achieving them?

This last issue—**choosing effective policy instruments to meet goals**—can be a surprisingly complex one, given the need to balance competing concerns. Some stakeholders advocate greater use of "market incentives," arguing that they can provide the same level of environmental protection at fewer cost. Others believe that giving consumers more information for judging risks can help further environmental goals with fewer burdens on gov-



ernmental agencies. Integrating the now-separate laws for protecting air, water, and land by issuing multimedia permits is championed by some as the best way to promote pollution prevention and technology innovation. And many communities support strict source-by-source controls to protect vulnerable individuals and populations from various pollutants.

Making sense of these arguments is difficult without a framework to help decisionmakers sort out these often conflicting recommendations in light of their own principal concerns. This OTA report fills that need.

The following user's guide is organized into three major sections:

- ***The Environmental Policy Toolbox:*** a discussion of 12 major policy tools, including their strengths, weaknesses, and frequency of use.
- ***Criteria for Comparing Tools:*** our evaluation of how effective these instruments are in achieving the values and interests—or **criteria**—decisionmakers are likely to weigh.
- ***Choosing Tools:*** a series of questions for matching a tool or tools to a specific problem. Choosing tools that satisfy several, much less all, of the criteria for a specific problem is the challenge. *Unfortunately, no "magic bullet" exists to meet everyone's expectations for every problem.*

To illustrate how decisionmakers might weigh these tradeoffs in choosing policy instruments, the report focuses on some of the major problems covered by the Clean Water Act, the Clean Air Act, and the Resource Conservation and Recovery Act. Why these statutes? Of the approximately $100 billion per year the United States spends on environmental protection, over 85 percent is for achieving the goals set forth in these acts. Under any of the environmental priority setting exercises we reviewed, the problems covered by these three laws were still ranked among the most serious problems to be addressed in the future. Thus, even with changing priorities and legal-institutional arrangements for environmental protection, tomorrow's environmental agenda will still contain many of the air, water, and land problems that remain from yesterday.

After discussing the tools, the criteria, and the framework for considering the choice of instruments, we briefly identify three major stumbling blocks that impede our ability to use otherwise desirable instruments. The first stumbling block is the often poor ability to quantitatively link emissions with harm, which often prevents us from relying on instruments that are explicitly risk based. The second is the lack of ability to adequately monitor emissions, which can restrict our ability to rely on performance-based approaches, even when we know the level of performance we wish to specify. And the third is the lack of sufficient empirical evidence about the strengths and weaknesses of many of these instruments.

THE ENVIRONMENTAL POLICY TOOLBOX

Environmental goals can be reached in many ways. Some ways are quite prescriptive, others are not. If one imagines a typical factory as having one or more pollution sources, it is easier to think of the many options available to Congress, the Environmental Protection Agency (EPA), and the states. Raw materials and products go into the factory, manufacturing processes within the factory are used to produce new products, and often, pollution is generated and released to the air or water or shipped off site for disposal, treatment, or storage. Sometimes the product itself results in pollution, while or after it is used.

To lower the pollution reaching the environment from such a factory, government can do any of several things:

- specify the end result—the amount of pollution that each source in the facility is allowed to discharge;
- specify what each source is to do to achieve the end result, such as install certain kinds of pollution control technology;
- help the source through a technical assistance program or a subsidy for cleaning up;

- specify the end result for each source, but allow facilities to trade these requirements within or among facilities;
- charge a fee on pollutant emissions to discourage releases to the environment;
- require only that the source publicly report emissions or risks to human health and the environment;
- require nothing in particular but hold sources liable for any resulting damages; or
- as is often the case, some combination of the approaches above.

Each of these approaches is a policy "instrument" or "tool," the topic of this OTA report. They are the means through which government encourages or forces sources to achieve society's environmental goals. Each policy instrument or tool has inherent strengths and weaknesses. Some tools address particular types of pollution problems better than others. Yet picking a tool involves more than identifying instruments that reduce emissions. It also involves making tradeoffs between values and interests commonly held by Congress and the public. For example, instruments most likely to provide significant assurance that an environmental goal will be met are quite likely to be more expensive than some other instruments. A full toolbox allows the decisionmaker to select tools that most effectively address values and interests of particular concern at the moment. And combinations of complementary instruments may allow decisionmakers to address multiple concerns, or to "shore up" weaknesses in a particular instrument.

A Catalog of Tools

Environmental policy tools could be categorized in any number of ways, depending on which attributes one wishes to emphasize. This assessment groups 12 policy instruments into two major categories depending on whether or not they impose fixed pollution reduction targets. These two categories help focus attention on a common concern in environmental policy—namely, the extent to which particular behavior is mandated by regulation. Table 1-1 provides a brief description of each of the 12 policy tools. Chapter 3 discusses each of the tools in greater detail.

Tools with Fixed Pollution Reduction Targets

Policy instruments that impose regulatory limits on environmentally harmful behavior vary in the extent to which they specify *how* a target entity should comply with emission limitations. For example, technology specifications might require the use of a specific pollution control device, while a harm-based standard describes a compliance target and leaves regulated entities free to choose their own method for complying with the limitation. An additional significant source of flexibility is whether the tool focuses on single sources or sets limits on cumulative emissions from multiple sources.

Tools that focus on single sources of pollution require regulated entities themselves to comply with emission limitations or face associated civil or criminal penalties. These tools are often called "traditional" or "command-and-control" approaches, because they historically are the most heavily used category of tools and often allow less flexibility than multisource tools.

Tools that focus on single sources of pollution include harm-based standards, design standards, technology specifications, and product bans and limitations. **Harm-based standards** prescribe the end results of regulatory compliance, not the means. Desired end results are based on health and environmental effects of different pollution levels and patterns. In contrast, the end results required by **design standards** are based on what a model technology might achieve. Sources are free to use the model technology or demonstrate that another technology or technique achieves equivalent results. **Technology specifications** designate the technology or technique a source must use to control its pollution. In its "pure" form, the specification is explicit. However, a design standard in some circumstances might be considered a de facto technology specification, when an entity has no practical opportunity to demonstrate equivalency of alternative approaches. **Product bans and limitations** ban or restrict manufacture, distribution,

TABLE 1-1: The Environmental Policy

Tools *With* Fixed Pollution Reduction Targets

Focus on single sources or products

Harm-based standards	A harm-based standard prescribes the end results, not the means, of regulatory compliance. Regulated entities are responsible for meeting some regulatory target but are largely free to choose or invent the easiest or cheapest methods to comply. Sometimes referred to as health-based standards or performance standards, harm-based standards are widely used, primarily in combination with design standards,
Design standards	A design standard is a requirement expressed in terms of the state of the art of pollution abatement at some point in time, for example, "best available" or "reasonably available" technology, In a permit, design standard requirements are typically, but not always, stated as the level of emissions control the model approach is capable of achieving. Design standards written as emission limits allow individual sources the freedom to achieve the required emissions control by using the model approach or equivalent means. Design standards are very widely used, most often as part of a technology-based strategy.
Technology specifications	A technology specification is a requirement expressed in terms of specific equipment or techniques. The standard is to be met by all entities; facilities are not free to choose their means of pollution abatement or prevention, Explicit technology specifications in statutes or regulations are very rare. However, some designs standards can be considered *de facto* technology specifications when it is extremely difficult to prove to the regulatory agency that an alternative to the model technology is equivalent.
Product bans and limitations	This regulatory approach bans or restricts production, processing, distribution, use, or disposal of substances that present unacceptable risks to health or the environment. It focuses on the commodity itself rather than polluting by-products. As a result, the instrument is used most heavily under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and other statutes where the hazard is the commodity.

Focus on multiple sources or products

Tradeable emissions	Emissions trading is achieved through government-issued permits that allow the owner to emit a specific quantity of pollutants over a specified period, and which can be bought from and sold to others. The government typically caps aggregate emissions from sources within a geographic region by issuing only the number of permits consistent with environmental goals. A relatively new approach to tradeable emissions is an "open market, " in which unregulated sources may opt into the program voluntarily. Emissions trading has been used most widely under the Clean Air Act and to a more limited degree to address water quality issues.
Integrated permitting	Integrated permits contain facility-wide emission limits, either for a single pollutant across multiple individual sources or media, or for several pollutants emitted to a single medium. An integrated permit might use one or several other environmental policy instruments, "Bubble" permits are used under the Clean Air Act, and to a very limited extent under the Clean Water Act. Other types of integrated permits are uncommon but are under study as part of several state pilot projects.
Challenge regulations	Challenge regulations ask target groups to change their behavior and work toward a specific environmental goal, with mandatory requirements imposed if the goal is not reached. The government identifies a goal and gives the groups time to select and implement an effective means of achieving it, Challenge regulations have the potential to be a less-intrusive way to achieve environmental goals. The concept of challenge regulation is attracting interest but is still uncommon as a stand-alone regulatory tool,

TABLE 1-1 (cont'd.): The Environmental Policy Toolbox

	Tools *Without* Fixed Pollution Reduction Targets
Pollution charges	Pollution charges require a regulated entity to pay a fixed dollar amount for each unit of pollution emitted or disposed. Pollution charges do not set a limit on emissions or production. Instead, the government must calculate what level of charge will change the behavior of regulated entities enough to achieve environmental objectives. Sources are free to choose whether to emit pollution and pay the charge or pay for the installation of controls to reduce emissions, This report considers only those charges set high enough to significantly alter environmentally harmful behavior, *not* charges used primarily for raising revenues. In the United States, pollution charges have been used for solid waste control but rarely for control of other types of pollution.
Liability	Liability requires entities that cause environmental harm to pay those who are harmed to the extent of the damage. Liability can provide a significant motivation for behavioral change because the dollar amounts involved can be quite large, This report focuses on statutory liability, *not* common law theories of liability or enforcement penalties. Several environmental statutes impose statutory liability, including CERCLA and the Oil Pollution Act.
Information reporting	Information reporting requires targeted entities to provide specified types of information to a government agency or to the public directly. Required information typically involves activities affecting environmental quality, such as emissions, product characteristics, or whether risk to the public exceeds a threshold. Information programs are widely used,
Subsidies	Subsidies are financial assistance given to entities as an incentive to change their behavior, or to help defray costs of mandatory standards, Subsidies might be provided by the government or by other parties, who thus bear part of the cost of environmentally beneficial controls or behavior. Government subsidies have historically been widely used, particularly in wastewater treatment. Subsidies from other parties are becoming more common as government budgets shrink,
Technical assistance	The government offers technical assistance to help targeted entities prevent or reduce pollution. These programs educate sources that might not be fully aware of the environmental consequences of their actions or of techniques or equipment to reduce those consequences. Technical assistance may take many forms, including manuals and guidance, training programs, and information clearinghouses. Some types of technical assistance, such as facility evaluations, are conditioned on facilities agreeing to respond with environmentally beneficial behavior, Technical assistance is very common, particularly in combination with other tools.

SOURCE: Office of Technology Assessment, 1995.

use, or disposal of substances that present unreasonable risks to health or the environment. Product bans and limitations focus on the commodity itself rather than polluting by-products from its manufacturing.

Single-source tools seem an effective choice when environmental results are of primary concern, with less focus on costs. Although the tools provide varying levels of flexibility when telling sources "what to do," all establish explicit emission targets for each source and, therefore, a relatively straightforward basis for verifying compliance. As a result, single-source tools are the most effective of the dozen tools that we consider in this report for providing assurance that environmental goals will be met. They address concerns about compliance costs less well than other instruments, because they are relatively less flexible and so reduce opportunities for achieving goals in a cost-effective manner. Also, they can impose substantial administrative burdens on regulatory agencies and regulated entities.

Some policy instruments that impose regulatory limits on pollution focus on multiple sources rather than single sources. Multisource tools allow a regulated entity additional flexibility in how it complies with emission limitations. A source can change its own behavior to fit within the limitations, or the source can make an arrangement with another entity for it to comply with the limitation on the source's behalf. This ability to transfer or negotiate responsibility among entities for changing behavior distinguishes multisource from single-source tools.

Multisource tools include tradeable emissions, challenge regulation, and integrated permitting. A **tradeable emissions** program often consists of government-issued permits that are transferable. The government agency sets a level of aggregate emissions consistent with environmental goals by issuing only the number of permits corresponding to that level. Entities are allowed to transfer their permits; they might choose to do so if the relative costs of emissions control make it more profitable or less expensive to transfer the permit to another entity. A relatively new use of tradeable emissions is for "open markets," in which government does not issue permits up front, and regulated or unregulated sources may opt into the program voluntarily.

With **challenge regulation**, the government establishes a clear, measurable target with a timetable for implementation, but the multiple sources in a target category are given responsibility for designing and implementing a program to achieve that target. Challenge regulation differs from purely voluntary programs in that the government specifies a credible alternative program or sanction that it will impose should progress toward targets be unsatisfactory.

Integrated permitting incorporates multiple requirements into a single permit, rather than having a permit for each emissions source at a facility. A facility-wide integrated permit might list emission limits for each source within the facility, or the permit might list a single limit per pollutant for the entire facility, allowing the facility to meet an overall emissions cap through any combination of controls. A multimedia integrated permit also may combine limitations on emissions to air, water, and land in a single permit, taking into account the potential for pollution to move between media.

Multisource tools are an effective choice when resource demands are of particular concern and environmental results a close second. The tools allow facilities to seek out the most cost-effective approach to achieving a particular level of aggregate emissions, whether through negotiating emissions control responsibilities with other facilities or through use of an integrated permit with flexible source emission limits at a particular facility. Multisource tools still require a particular level of pollution abatement and so provide a significant degree of assurance that environmental goals will be met, although perhaps less assurance than with the straightforward single-source tools. The actual degree of assurance depends on our capability to monitor regulated pollutants.

Tools Without Fixed Pollution Reduction Targets

The second major category of tools shown in table 1-1 comprises tools that encourage pollution prevention and control without setting specific emission targets. Some of these instruments are nonregulatory in nature, while others require a particular action, such as payment per unit of emissions or an emissions report. Note that even the regulatory tools in this category require something other than a specific level of pollution prevention or control. Tools that move behavior in the right direction fall into two subgroups: 1) tools that make it easier or less expensive to lower pollution by providing knowledge or financial assistance; and 2) tools that raise the financial stakes of continuing to behave in environmentally harmful ways.

Tools that encourage facilities to prevent or control pollution include technical assistance and subsidies. Both approaches assume that sources will be willing to change once they know of the benefits of alternative types of behavior and are more likely to change if the expense is at least partially offset by others. **Technical assistance** helps entities to make better environmental choices by clarifying the consequences of their actions and what techniques or equipment reduce those consequences. Technical assistance also may be focused on educating the general public about the environmental implications of existing and proposed programs and policies. **Subsidies** provide various forms of financial assistance, which can act as an incentive for entities to change their behavior or help entities having difficulty complying with imposed standards. Subsidies might be provided by the government or by other parties. Subsidies can come in many forms: grants, low- or no-interest loans, preferential tax treatment, and deposit-refund systems.

Tools that increase the cost to sources of environmentally harmful behavior include pollution charges, information reporting, and liability. These tools are based on the assumption that sources will emit less if their pollution costs them something, either as direct payments to an agency or harmed parties or indirectly in terms of reputation. **Pollution charges** require a regulated entity to pay a fixed dollar amount for each unit of pollution emitted or disposed. Pollution charges do not set a limit on emissions or production; instead, the government must calculate what level of charge will change the behavior of regulated entities enough to achieve environmental objectives. Sources are free to choose whether to emit pollution and pay the charge or to pay for the installation of controls to reduce emissions subject to the charge. In this assessment, OTA is focusing on pollution charges that create a behavioral incentive and do not merely raise revenue.

Information reporting affects target entity behavior somewhat less directly than pollution charges by helping to increase public awareness of entities' pollution. The hope is that the public's heightened awareness will encourage entities to be "good neighbors" and reduce their pollution, and that public support for pollution control programs will increase.

Liability provisions require those entities undertaking activities that impose pollution or other environmental harms on others to pay those who are harmed to the extent of the damage. Liability can provide entities with a significant motivation for environmentally sound behavior because the dollar amounts involved can be huge. Liability is imposed two ways: 1) by common-law theories like negligence or nuisance, or 2) by statute, such as in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA).

Note that in this assessment, we are considering only *statutory* liability. We are not considering enforcement and compliance penalties as part of liability. Obviously, these also can greatly increase the cost of environmentally harmful activities, but they are beyond the scope of this assessment. Enforcement and compliance penalties are a necessary component of *any* of the regulatory instruments this assessment addresses.

Tools that move behavior in the right direction, without setting fixed pollution control targets, are particularly appropriate if the decisionmaker desires an environmental program that can readily adapt to changing science and control capabilities. Because these tools do not mandate any particular behavior, they should be used with caution where assurance of meeting environmental goals is a primary criterion.

How We Use Tools

The environmental policy toolbox contains many tools. Table 1-2 displays the primary policy instruments used to control air pollution, water pollution, and hazardous waste under three major U.S. statutes. For each of the approximately 30 pollution control programs addressed by the Clean Air Act (CAA), the Clean Water Act (CWA), and the Resource Conservation and Recovery Act (RCRA), the table displays the primary policy instruments (marked with dark gray) as well as several auxiliary policy instruments (light gray) used under current law. Combinations of tools are common. The United States traditionally has relied most heavily on two regulatory tools that place direct pollution limits on single sources: design standards and harm-based standards. However, the other tools in the regulatory toolbox—while less frequently used—certainly should not be considered unused and theoretical. Table 1-2 shows that we have turned to tradeable emissions, information programs, and other tools for numerous programs.

The country's occasional reliance on "nontraditional" tools is hardly new. Many "new ap-

TABLE 1-2: Policy Instruments Used to Control Air Pollution, Water Pollution, and Hazardous Waste

	Tools *With* Fixed Pollution Reduction Targets							Tools *Without* Fixed Pollution Reduction Targets				
	Single-source tools				Multisource tools							
	Product bans	Technology specifications	Design standards	Harm-based standards	Integrated permitting	Tradeable emissions	Challenge regulations	Pollution charges	Liability	Information reporting	Subsidies	Technical assistance
Clean Water Act												
Point sources												
Industrial												
Existing sources												
Conventional pollutants			■	■								
Toxic/grey-area pollutants			■	■					■	■		
New sources												
Conventional pollutants			■	■								
Toxic/grey-area pollutants			■	■					■	■		
Indirect dischargers												
Existing sources												
Conventional pollutants												
Toxic/grey-area pollutants			■						■	■		
New sources												
Conventional pollutants												
Toxic/grey-area pollutants			■						■	■		
POTW's												
Conventional pollutants			■	■							■	■
Toxic/grey-area pollutants			■	■					■		■	■
Stormwater												
Industrial sources			■	■								
Municipal sources			■	■							■	
Nonpoint sources												
All sources						□					■	■
Clean Air Act												
Criteria air pollutants												
Nonattainment areas												
Stationary sources												
Existing sources			□	■	□	■						□
New sources			■	■	■	■						□

	Tools *With* Fixed Pollution Reduction Targets							Tools *Without* Fixed Pollution Reduction Targets				
	Single-source tools				Multisource tools							
	Product bans	Technology specifications	Design standards	Harm-based standards	Integrated permitting	Tradeable emissions	Challenge regulations	Pollution charges	Liability	Information reporting	Subsidies	Technical assistance
Mobile sources												
Exhaust emissions			■	□		□						
Refueling and evaporative emissions			■									
Fuel requirements	■		■			□						
Maintenance			■									
Transportation controls			■	■								
Attainment areas												
Stationary sources												
Existing sources				■								
New sources			■	□								
Mobile sources												
Exhaust emissions			■			□						
Refueling and evap. emis.			■									
Fuel requirements	■					□						
Hazardous air pollutants												
Existing sources			■	■						■		□
New sources			■	■						■		□
Acid deposition control												
Sulfur dioxide						■						
Nitrogen oxides			■									
Stratospheric ozone protection												
All sources	■					■		■				
Resource Conservation and Recovery Act												
Liquids in landfills			■							□		
Land disposal			■							□		
Land ban and predisposal treatment			■	■						□		
Incineration			■	■						□		

■ = Primary policy instrument □ = Auxiliary instruments

SOURCE: Office of Technology Assessment, 1995.

proaches" to environmental regulation have been used for years, including tradeable emissions, integrated permitting, liability provisions, information reporting, subsidies, and technical assistance. Box 1-1 highlights several programs over the last two decades that have used these approaches. Generally, familiarity and "comfort level" with such tools seem to be growing.

The balance of this section will discuss where and how the various environmental policy tools are used.

Use of Tools with Fixed Pollution Reduction Targets

Single-source tools currently are very widely used. As shown in table 1-2, **design standards** are the foundation for many pollution control programs under the Clean Air Act, Clean Water Act, and RCRA. Design standards are used for the CWA's national discharge limitations requirements, the CAA's New Source Performance Standards, and RCRA's requirements for treatment of hazardous waste destined for land disposal. **Harm-based standards** are often combined with design standards to provide a "safety net" in case goals are not achieved under design standards. For example, the Clean Water Act calls for harm-based site-specific discharge limits if the national limits based on design standards are not enough to meet water quality standards.

Similarly, the Clean Air Act requires EPA to set harm-based standards to reduce residual risks that remain after implementing "maximum achievable control technology" (MACT). This kind of safety net has often seemed necessary because design standards are technology based, calling for levels of control provided by technologies such as the "best available" or "reasonably available." These technology levels may not always reduce potential environmental harm to acceptable levels. Harm-based standards establish emissions control requirements based on the potential harm from different levels of contaminants in the environment. We use design standards heavily because they provide a high level of assurance and are relatively easy to implement, but often combine them with harm-based standards to make sure goals are met.

Note, though, that harm-based standards are not always combined with design standards to make requirements stricter; they can also be used as a reality check on a design standard when its reference technology otherwise would call for overcontrol. Some pollutants may have a known threshold, below which human exposure is presumably safe. This threshold might be higher than the emissions limit established by a design standard's reference technology. For toxic air pollutants with known thresholds, Congress allows EPA to set an emissions limit based on this health threshold, with an ample margin of safety, instead of requiring MACT.

Product bans and limitations are used, albeit infrequently, under the Clean Air Act. For example, the Clean Air Act places a phased-in ban on stratospheric ozone-depleting chemicals. Product bans are heavily used under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and the Toxic Substances Control Act (TSCA), two statutes with a product orientation. Explicit **technology specifications** are used rarely, if ever, because of their inflexibility and potential cost. De facto technology specifications probably are more common, resulting when a design standard offers no practical way of demonstrating equivalency of an alternative to the model technology or approach. The prevalence of de facto technology specifications is unknown.

Multisource tools have received increasing attention in recent years, because they are believed to achieve environmental quality goals more cost effectively than single-source approaches. During the 1980s, EPA relied on **tradeable emissions** in several CAA regulatory programs and policies, including the phasedown of lead in gasoline and the Air Emissions Trading Policy for criteria pollutants. The first statutory trading program was established under the Clean Air Act Amendments of 1990, which set up a national program using tradeable emissions to control acid rain.

The 1990 Amendments also encouraged EPA and states to consider using trading in numerous

BOX 1-1: Examples of Past Uses of Environmental Policy Tools

Year	Instrument	Program or Project
1970	Harm-based standards	National ambient air quality standards (NAAQS), to be set at a level designed to protect public health with an adequate margin of safety.
1972	Design standards	Best available control technology (BACT) and other effluent limitations, a national baseline level of control under the Clean Water Act that is applicable regardless of the quality of the waters receiving effluent.
972	Subsidies	Construction grant program, providing federal financial assistance to municipalities constructing the wastewater treatment facilities necessary to comply with Clean Water Act effluent limits.
976	Tradeable emissions	Offset policy, allowing facilities to locate in areas not meeting air quality standards, provided they offset their emissions with reductions from existing facilities.
979	Integrated permitting	"Bubble" Policy, allowing firms to devise their own mix of plant controls to meet an overall emission limit for a particular air pollutant.
980	Liability	Superfund joint and several liability for hazardous waste cleanup, creating incentives for firms to reduce current waste generation by establishing their liability for future sites.
1982, 1985	Product ban, tradeable emissions	Phased-in ban on lead in gasoline, using tradable credits for lead reduction to soften economic effects.
1986	Information reporting	Toxics Release Inventory, requiring self-reporting of emissions to air, water, and land by manufacturers.
1986	Information reporting	California's Proposition 65, requiring public warning of the potential cancer or reproductive effects of 542 listed chemicals either emitted or present in products.
1986	Tradeable emissions, integrated permitting	Air Emissions Trading Policy Statement, integrating offset and bubble policies, and endorsing use of '(generic bubbles. "
1989	Subsidies	Pollution Prevention Incentives for States (PPIS) grant program, promoting use of pollution prevention.
1990	Tradeable emissions	Acid rain provisions in Clean Air Act Amendments, establishing a marketable permit system for $S0_2$.
1990	Design standards	Maximum achievable control technology (MACT), required for control of toxic air emissions.
1990	Product ban, tradeable emissions, pollution charges	Chlorofluorocarbon (CFC) phaseout program with baseline production allowances, allowing transfer of allowances between firms, and levying charges based on amount emitted and its ozone-depleting factor.
1991	Integrated permitting	Multimedia permit pilot program, implemented as part of New Jersey's pollution prevention program.
1994	Tradeable emissions	RECLAIM program, which establishes a trading program for sources of $S0_2$ and NO_x in the South Coast Air Quality Management District of Southern California.

SOURCE: Office of Technology Assessment, 1995 other programs as well. States and localities have been receptive to the tradeable emissions idea. The best-known nonfederal trading program is the Regional Clean Air Incentives Market (RECLAIM) in Southern California, which includes a market in nitrogen oxides (NO_x) and sulfur dioxide (SO_2) and reduction credits for auto scrapping. Pennsylvania and Texas have created emissions trading programs for volatile organic compounds (VOCs) and NO_x. Emissions trading has also been used to control water pollution, particularly diffuse, "nonpoint" sources of pollutants. A few local programs in Colorado and North Carolina allow trades between facilities and nonpoint sources; Wisconsin adopted a trading program for facilities in the early 1980s.

Challenge regulation and integrated permitting are multisource tools not yet as widely accepted as trading. Nonetheless, the concept of **challenge regulation** is receiving increasing attention in the United States, in part because of interest in efforts under way in other countries. Germany's "Green Dot" program challenges industry to reduce its solid waste, with a program for government intervention if goals are not met. In the Netherlands, the government has been setting broad goals and entering into "covenants" outlining industry's plan for meeting those goals, typically over a period of about 10 years. The 33/50 program in the United States is very similar in concept to challenge regulation, encouraging the chemical industry to reduce a percentage of its chemical emissions by 1995. However, the 33/50 program, unlike the concept of challenge regulation, does not promise government intervention if goals are not met.

Integrated permits have been more widely used in the United States than has challenge regulation, but nonetheless on a limited scale. Several states, including New Jersey and Minnesota, are currently experimenting with integrated permits that use a plantwide emissions cap with limits that float among sources at the facility. The "bubble" form of integrated permitting, in which individual emission limits for sources within a facility are fixed, was often used during the mid-1980s but is less commonly used today.

Use of Tools Without Fixed Pollution Reduction Targets

Tools that encourage pollution control without setting specific emission targets have been less extensively used than tools that impose fixed limits. **Pollution charges** generally have not been used in the United States at a level calculated to change behavior, but have been used more to provide revenue for offsetting administrative costs. A notable exception is the use of pollution charges for solid waste disposal. Approximately 100 localities have used volume-based fees as an incentive in residential waste programs to encourage recycling and make explicit the cost of waste disposal. These programs typically charge per waste container, with increasing rates for higher volumes of service.

Pollution charges are used more frequently in Europe than in the United States, though even in Europe they are more often used to generate revenue than set high enough to lower emissions significantly. The Organisation for Economic Cooperation and Development (OECD) reports that member countries are using emission fees to address a variety of air pollutants, primarily SO_2 and NO_x, as well as household or industrial waste and hazardous waste. For example, Sweden has placed charges on NO_x emissions in order to speed up compliance with new emission guidelines to be imposed in 1995. Charges are levied on the actual emissions of heat and power producers with a capacity of over 10 MW and production exceeding 50 GWh. The fees are then rebated to the facilities subject to the charge, but on the basis of their energy production. Thus, funds are redistributed between high- and low-emitting facilities. In 1992, the actual emissions reduction was between 30 and 40 percent, exceeding the predicted 20 to 25 percent reduction. Several OECD member countries are also levying a pollution charge on landfilled and incinerated wastes, as well as experimenting with pay-per-bag systems.

Information reporting is becoming increasingly prevalent with the advent of the federal Emergency Planning and Community Right-to-Know Act and similar state public disclosure laws. For example, the California Air Toxics "Hot Spots" Information and Assessment Act established an emissions reporting program to inventory statewide emissions of toxic substances, identify and assess the localized risks of air contaminants, and provide information to the pubic about the impact of those emissions on public health. New Jersey requires disclosure of potential hazardous substance cleanup prior to closure or transfer of land ownership.

Liability is not used under the Clean Air Act or RCRA, although the Clean Water Act has established liability for oil and hazardous substance spills. The tool is more heavily used under other environmental laws, such as the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the Oil Pollution Act.

Technical assistance and subsidies are two more approaches that encourage pollution prevention or control. These two tools are widely used, both alone and in conjunction with other tools, under the CWA, the CAA, and RCRA.

One of the largest environmental programs to date is a **subsidy** under the Clean Water Act that has provided over $60 billion in wastewater treatment grants and loans to help offset the cost of building the public wastewater treatment works called for under the statute. Note, however, that these subsidies are not used alone; they are used to defray costs associated with a requirement to achieve a specified treatment level. Generally, technical assistance and government subsidies have been most heavily used where sources are small and less technically sophisticated or are publicly owned.

Subsidies from nongovernmental entities are more broadly available, particularly in the form of deposit-refund programs. Such programs seem likely to become increasingly important as government funds available for subsidies continue to shrink. Under deposit-refund programs, purchasers of a commodity pay an additional charge, which is rebated to whoever returns the commodity or container for proper disposal. This rebate, when the person returning the commodity is someone other than the purchaser, is effectively a subsidy from one person to another. Ten states have enacted deposit-refund programs in the form of "bottle bills" to reduce littering and costs for disposal. States report that 72 to 97 percent of deposit containers are returned for recycling. Deposit-refund programs are spreading beyond beverage containers. For example, Maine has a deposit-refund system for lead acid batteries and pesticide containers.

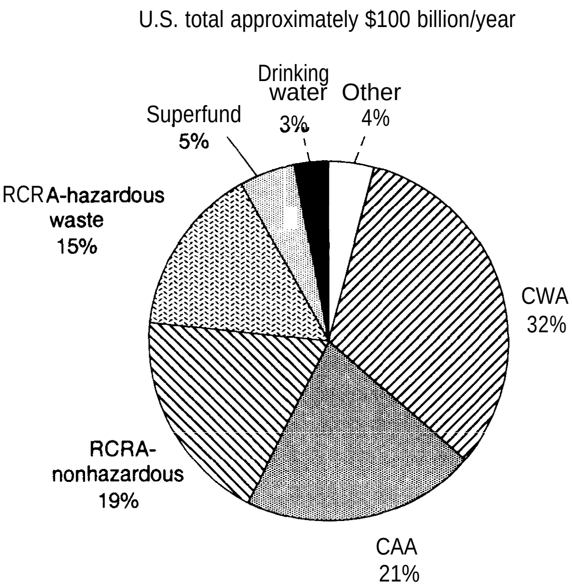
OECD countries also make heavy use of subsidies, including grants, subsidized-interest loans, income tax allowances, and deposit-refund programs. Subsidies are offered to promote research on pollution control technologies, lowering the effective cost of certain control options and compensating firms or sectors that would otherwise be seriously affected by pollution control regulations. Germany has the highest number of subsidies, relying primarily on subsidized-interest loans to speed compliance and to assist small firms.

Technical assistance is sometimes the primary tool used to further program goals. For example, the Clean Air Act established the Small Business Stationary Source Technical and Environmental Compliance Assistance Programs, targeted at small businesses that are newly subject to regulation. Diffuse nonpoint sources of water pollution are addressed primarily through voluntary implementation of "best management practices" (BMPs) developed by federal and state agencies. More often, technical assistance is used as an auxiliary tool to assist targeted entities in complying with requirements. For example, federal and state agencies provide training for operators of publicly owned wastewater treatment plants built with subsidized dollars to comply with Clean Water Act requirements.

Today's Problems

Before we consider the values and interests policymakers bring to problem solving, we need to briefly review the kinds of problems the nation is working on today and may face tomorrow. As we shall see in later sections, our choice of policy tools is heavily influenced by the characteristics of the problem being addressed.

FIGURE 1-1: Pollution Abatement Expenditures, 1991



SOURCE: Office of Technology Assessment, modified from Don Garner, "Pollution Abatement Costs," Contractor Report to OTA, 1994.

Today, U.S. businesses, individuals, and governments at all levels spend about $100 billion per year controlling and preventing pollution. While controlling pollution more wisely may allow us to lower these costs, the demands from a growing economy can be expected to offset some of, or even overshadow, these gains. Understanding which problems require the largest expenditures, and who pays the bills, can help identify those targets that may yield the largest cost savings. There are certainly many inefficiencies in the way the nation protects the environment. It makes sense to look first at those areas that cost the most.

About 85 percent of the approximately $100 billion spent annually on pollution abatement is tied to the requirements of the CAA, the CWA, and RCRA—the three statutes covered in this report----or similar state and local programs. Figure 1-1 displays current environmental expenditures under these and other environmental statutes. About one-third of the total is spent controlling water pollution; somewhat over 20 percent controlling air pollution; another 20 percent disposing solid waste; 15 percent preventing, treating, and storing hazardous waste; 5 percent cleaning up old hazardous waste sites; and about 1 to 3 percent each on drinking water, pesticides, and other toxic chemical programs. As can be seen in table 1-3, about 45 percent of the total is spent by government (with local government spending the largest share), 40 percent by business, and 15 percent directly by households.

As mentioned above, about one-third of today's abatement costs are spent to maintain and improve the quality of the nation's surface water. The vast majority of this expenditure is to clean up wastewater from identifiable municipal and industrial sources. While many of these sources have significantly reduced their discharges over the last 25 years, many lakes, streams, and estuaries are still impaired. Another source of water pollution—nonpoint source pollution from agricultural and urban runoff-is ranked among the very top of remaining risks to ecosystems. Some urban areas have already made considerable investments, but much is left to do. Relatively little has been spent on controlling agricultural nonpoint source pollution. The costs of controlling many of these sources in the future might be quite high.

Of the total water pollution control costs, close to 65 percent is spent by federal, state, and, primarily, local governments (see table 1-3). Business spends about 30 percent and the remainder is spent directly by households.

Information on water quality trends—that is, the progress we've made over the last two decades—is almost completely lacking. Much anecdotal information and data collected by the U.S. Geological Survey (USGS) on a limited number of sites nationwide indicate some improvement for some contaminants (e.g., bacteria and phosphorus). However, for other contaminants (e.g., dissolved oxygen and nitrates), the USGS data show no discernible trend (91).

Although data are sketchy even about *today's* water quality, currently about 40 percent of the nation's river miles that have been assessed either do not support or only partially support, the beneficial use designated by the state (e.g., swimming,

TABLE 1-3: U.S. Pollution Abatement Expenditures, by Statute and Sector, 1991

Sector	Total	Clean Water Act	Clean Air Act	RCRA Solid Waste	RCRA Hazardous Waste	Superfund	Safe Drinking Water Act
Government:							
Federal	13%	13%	7%	3%	15%	67%	3%
State	3%	7%	—	—	—	6%	1%
Local	28%	43%	3%	45%	5%	—	79%
Total Government	44%	63%	10%	48%	20%	73%	83%
Private:							
Households	15%	61%	35%	27%	—	—	—
Business	40%	30%	55%	24%	80%	27%	—
Total Private	56%	37%	90%	52%	80%	27%	17%
Total:							
Total Government and Private	100%	100%	100%	100%	100%	100%	100'%0

SOURCE: Office of Technology Assessment, modified from Don Garner, "Pollution Abatement Costs, " contractor report to OTA, 1994

fishing, drinking, or support of aquatic life). About 45 percent of assessed lake area and 35 percent of estuaries do not support, or only partially support, designated use (204). Agriculture is thought to be the single largest source of remaining river and lake water quality problems. Sewage treatment plants and urban runoff are the largest contributors to remaining estuarine water quality problems.

Somewhat over 20 percent of today's abatement expenditures are for air pollution control. These expenditures have contributed to a 25 percent drop in emissions of carbon monoxide, sulfur dioxide, and volatile organic compounds since 1970. Particulate matter has dropped about 50 percent and lead emissions have dropped by 98 percent since 1970. Nitrogen oxide is the only criteria air pollutant to have increased since 1970, by about 10 percent (205).

Still, much remains to be done. Many areas still do not meet air quality standards for criteria air pollutants such as urban ozone. About 60 million people live in counties with air quality levels that do not meet the national standards for one or more pollutants. About 50 million people live in counties that exceed air quality standards for urban ozone. About 12 million people live in counties that exceed air quality standards for carbon monoxide, and about 9 million people live in counties that exceed standards for particulate matter (21 1). The recently amended program to control emissions of hazardous air pollutants is still in its early stages.

In contrast to water pollution control costs, most air pollution control costs are borne by the private sector. About 55 percent is spent by business and 35 percent by households (primarily for auto pollution control devices).

Just under 20 percent of total costs are spent on solid waste. As we shall see in the next section, municipal solid waste is often judged to be among the lower risks to both human health and natural ecosystems. However, siting landfills is becoming increasingly difficult, which results in higher disposal costs. Per capita net discards of solid waste have been declining over the past decade due in part to increased rates of recycling, but not fast enough to offset population growth (48). Solid waste disposal costs are shared about equally between government and the private sector.

Another 20 percent of the total is spent on hazardous waste. About three-quarters is spent dealing with hazardous waste under RCRA and the remainder to clean up existing hazardous waste sites under CERCLA (Superfund). Most of the costs of dealing with hazardous waste are borne by business.

The remaining 10 percent of the total is spent on regulations under the Safe Drinking Water Act, regulating pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), regulating new chemicals under the Toxic Substances Control Act (TSCA), and a few other statutes implemented by EPA. Most of the drinking water costs are spent by government, and the bulk of the costs under the other statutes is spent by the private sector. As we shall see in the next section, the risks from drinking water and pesticides rank quite high on comparative assessments of risk.

CRITERIA FOR COMPARING TOOLS

Although the nation's near-term commitment to solving environmental problems is evident in the strong goals Congress has established, considerable controversy exists about how best to achieve these and future goals. Ideally, decisionmakers would like to choose policy instruments that would move the country toward a cleaner environment at the lowest possible cost while accommodating the increasingly rapid changes in U.S. scientific and technological capabilities. However, satisfying all of these criteria has seldom been possible in the past—and may be even more difficult in the future.

One potential strategy for minimizing tradeoffs among strongly held, yet at times competing, criteria is to choose policy instruments according to their strengths on the most important one or two criteria and then rely on additional instruments to shore up overall performance on the others. In the past, for example, U.S. policymakers have relied heavily on harm-based standards and design standards because they could tell on a source-by-source basis the progress being made in cleaning up the environment. However, by emphasizing assurance of meeting goals, in many instances policymakers chose—implicitly or explicitly—to give up some of the potential for cost savings and technology innovation.

Rather than discard harm-based standards or design standards, policymakers have experimented with combining them with other approaches such as tradeable emissions or integrated permitting. These combinations offer firms more flexibility to choose the means or timing of compliance, enabling the implementation of more cost-effective solutions for individual firms with relatively little loss of the assurance the public wants. However, the use of these more flexible approaches may raise concerns that the proportionate burden of adverse environmental effects will be shifted from one group to another, even though everyone is ultimately better off. Careful monitoring and required information reporting can help with some of those concerns.

This part of the report explores how knowledge about differences in instrument performance on a set of environmental criteria might guide a policymaker's choices. For each criterion, we present OTA's overall judgments about the comparative effectiveness of policy instruments, indicating which might be used confidently or which more cautiously. The details of these evaluations—necessarily subjective but based on experience and expert judgment—are explained in more detail in chapter 4.

The Criteria and Instrument Performance

Most environmental policy debates reflect three broad, but at times conflicting, themes. The first theme, **costs and burdens** for society and for the sources, addresses the public's concern that we pursue our environmental goals at the lowest possible cost and with the fairest allocation of burden among companies and between government and industry. The second theme, **environmental results**, addresses the public's demand that we not only meet our goals but that we pursue these goals in appropriate ways. The last theme, **change,** reflects the recognition that adaptable programs that facilitate continual improvements in policies may be essential for encouraging new scientific and technological solutions. Ideally, we would want to

TABLE 1-4: Criteria And Factors Used For Comparing Instruments

CRITERIA	FACTORS
COSTS AND BURDENS	
Cost-Effectiveness and Fairness Are we protecting human health and the environment at the lowest possible cost and with the fairest allocation of burdens for sources?	▪ Cost-effectiveness for society ▪ Cost-effectiveness for sources ▪ Fairness to sources ▪ Administrative burden for sources
Demands on Government Are we protecting human health and the environment at the lowest possible cost and with the best use of resources for government?	▪ costs ▪ Ease of analysis
ENVIRONMENTAL RESULTS	
Assurance of Meeting Goals Do stakeholders have confidence that environmental goals will be or have been met?	▪ Action forcing ▪ Monitoring capability ▪ Familiarity with use
Pollution Prevention Can the approach promote use of strategies for preventing rather than controlling pollution?	▪ Gives prevention an advantage ▪ Focuses on learning
Environmental Equity and Justice Does the approach seek equality of outcomes, full participation by affected communities in decision-making, and freedom from bias in policy implementation?	▪ Distributional outcomes ▪ Effective participation ▪ Remediation
CHANGE	
Adaptability How easily can the approach be adapted to new scientific information or abatement capability?	▪ Ease of program modification ▪ Ease of change for sources
Technology Innovation and Diffusion Are we encouraging new ways to achieve our environmental goals that lead to improved performance in quality and costs?	▪ Innovation in the regulated industries ▪ Innovation in the EG&S industry ▪ Diffusion of known technologies

SOURCE: Office of Technology Assessment, 1995.

choose policy tools to achieve all three, and we have, at times, sought all three. But our experiences to date indicate that such an ideal has been difficult, if not impossible, to accomplish with the tools we have.

Sharpening our focus to the details underlying these broad themes, OTA identified seven strongly held public values and interests—referred to as criteria in this report-that policymakers are likely to consider when adopting environmental policies (see table 1-4). Although lack of sufficient experience with many of the instruments made us less certain in some instances about how they might perform, we found that assessing instrument choice from the perspective of this set of criteria revealed distinctive and useful guidelines for policymakers.

The remainder of this section describes the comparative ratings of the instruments on each of the criteria. To summarize our judgments, we use the same set of ratings and symbols that appear in the more detailed explanations of comparative instrument performance found in chapter 4 of this report. Since most of the instruments tend to be about average in achieving a particular criterion (represented by a single dot), the following discussion focuses on those that are likely to be particularly effective (represented by a filled-in circle) and thus can be used with confidence; those for which it depends (represented by a partially filled-in circle) on the specifics of implementation or the characteristics of a problem; and those Congress might want to use with caution (represented by a triangular "caution" sign) because they may create problems with respect to the particular criterion. Although we expect that those rated "it depends" would usually be quite effective, we also anticipate that they may turn out to be only about average, depending on the specific situation.

■ Costs and Burdens

Congress has seldom set goals without including a concession to the costs and burdens imposed. However, at times the desire to provide sufficient protection of human health or the environment has resulted in strict source controls and additional requirements, such as continuous monitoring, that can add significant costs and burdens.

One of the most consistent criticisms of environmental protection programs in the United States has been that they force very inefficient activities on companies, reducing productivity and placing U.S. firms at a competitive disadvantage. And, in fact, establishing policies that are effective at improving both *cost-effectiveness and fairness* has not been an easy task.

Concern about the administrative *demands on government* has also intensified. Especially pertinent to this study have been claims that some alternatives for protecting human health and the environment offer the advantage of placing a significantly lighter burden on government, either by shifting the burdens toward other groups—industry or consumers-or by loosening the level of control altogether.

Cost-Effectiveness and Fairness

- ***Effective: Tradeable emissions***

O It depends: ***Integrated permitting, challenge regulations, information reporting, technical assistance***

V Use with caution: ***Product bans, technology specifications***

If policymakers want to emphasize more cost-effective responses to environmental problems, the key may be to choose those instruments that shift responsibility for determining the means and timing of compliance to individual firms or groups of firms. Although such a shift does not guarantee a cost-effective result, firms with some flexibility to determine the means and timing of their responses are more likely to be able to identify and implement least-cost solutions.

The most cost-effective tools are multisource instruments such as integrated permitting, tradeable emissions, and challenge regulations, which allow firms the flexibility to reallocate their resources and efforts at pollution reduction either internally or through cooperation or competition with other firms. Tradeable emissions offer the best opportunities for lowering costs through purchasing credits to offset the need for source controls or by the sale or banking of emission credits. Challenge regulations are likely to be very cost effective and fair inmost cases, yet lack of participation by firms or the need to make tradeoffs when designing programs may reduce their effectiveness in some cases. Similarly, since integrated permitting restricts firm flexibility to the facility level, it offers fewer opportunities to seek a solution for a particular problem.

All three of these multisource instruments also have the potential to increase the administrative burden for participating firms. For most large firms, this added burden may be considered more welcome than the rigidity of point-by-point approaches such as design standards. In contrast, for small firms without the capacity for R&D or strategic planning, a uniform approach, especially when accompanied by technical assistance programs, may be more appropriate. Such technical assistance programs may be very cost effective for delivering information and expertise to sources that are unregulated yet discharge pollutants.

Information reporting is another relatively cost-effective tool for sources because of the flexibility they have to do whatever they wish to reduce pollution. Of course, if firms decide to do nothing to reduce discharges, then reporting would be costly for society. For example, asking firms tore-port emissions by weight may not be the most cost-effective way to achieve reductions since such measures do not accurately reflect risks to society. However, asking firms to estimate possible harm using risk analysis would add considerable administrative burden.

Technology specifications and product bans and limitations, which force a uniform solution on all firms regardless of their control costs, severely constrain opportunities for a cost-effective or fair solution and thus are used very sparingly. De facto technology specifications, described above in the section on tools, also reduce the ability of sources or facilities to seek cost-effective solutions.

Demands on Government

- **Effective:** ***Information reporting***

O It depends: ***Challenge regulations***

V Use with caution: ***Harm-based standards, subsidies***

If information reporting programs are well designed, they place comparatively little burden on government to administer and shift most of the implementation demands to the firms instead. Requiring firms to gather and report information about their environmental activities could improve the way they consider and make choices about pollution reduction, with little cost to governmental agencies other than reviewing data submissions, validating a sample of the reports for accuracy, and assisting in many instances with making data accessible to the public.

Challenge regulations also shift responsibility toward firms, lessening the costs and analytical burden on government in most instances. However, the reduced role of government may depend both on how well government designs the challenge and how well industry meets the challenge. Experiences in Germany and the Netherlands, for example, have demonstrated that government may have to become involved in program design and implementation if industry encounters problems.

Other instruments that require the government to establish and enforce standards on a source-by-source basis place a very heavy resource burden on governmental agencies. Of the two most heavily used instruments-harm-based standards and design standards—harm-based standards are probably the more difficult for government to establish. In fact, EPA's early experiences with trying to establish these in the 1970s were responsible for some of the shift toward greater use of design standards.

The administrative demands on government may also be high when developing complicated programs based on trading or long-range challenges—at least in the short term. Agencies may be facing uncertain financial and administrative ventures in pioneering programs like RECLAIM, an air pollution emissions trading program in Los Angeles. Similarly, integrated permitting, which could introduce some flexibility and reduce the hassle of source-by-source permitting, has so far been a very resource-intensive undertaking. More experience with integrated permits may improve the capacity of both industry and government to complete them with less effort.

Subsidies, on the other hand, may place substantial financial demands on government. However, direct subsidies currently represent relatively small expenditures except for federal subsidies for municipal sewage treatment plants.

■ Environmental Results

For many people, achieving the desired environmental results remains the "bottom line." Reducing costs and burdens may be desirable, as long as we do not compromise too much in the way of goals. Somewhat perversely, however, those instruments that are the most effective at ensuring environmental progress are among the most widely criticized for restricting industry responses and placing heavy demands on governmental agencies while failing to accommodate change.

In addition, our definition of what constitutes satisfactory environmental results has recently broadened beyond the basic demand for ***assurance of meeting goals*** at a specific place and time. Also, Congress has previously stated that it prefers that goals be met through *pollution prevention* strategies rather than those that simply reduce or control discharges. Similarly, the concept of *environmental equity and justice* has reframed our measures of satisfactory progress to include the distribution effects of environmental policies on minority and low-income individuals and communities and their level of involvement in policymaking.

Assurance of Meeting Goals

- ● ***Effective: Product bans, technology specifications, design standards, harm-based standards, integrated permitting***
- ◐ ***It depends: Tradeable emissions***
- ▽ ***Use with caution: Information reporting, subsidies, technical assistance***

Primarily out of concern for ensuring progress, policymakers have relied heavily on instruments—harm-based and design standards—that require specific levels of pollution reduction on a point--by-point or source-by-source basis. The direct tie between a source and allowable discharge in emission levels provided the basis for verifying compliance. Specific bans and limitations can accomplish the same level of assurance for products, although they are not widely used under the CAA, CWA, and RCRA.

Among those instruments that broaden pollution reduction targets to cover multiple rather than single sources, we rank integrated permitting as providing similar levels of assurance as harm-based and design standards. The fact that an integrated permit still links the required pollution reduction to the facility level (although source levels within the facility may be allowed to control with more flexibility) provides the public with the means to hold the facility responsible for meeting the goals. For those pollutants for which monitoring capabilities are reasonably advanced, other multisource approaches, such as tradeable emissions, can provide a high degree of assurance. However, if monitoring will be difficult, decisionmakers might want to choose another tool.

Instruments that do not require pollution reduction, although they may push industry in that direction, must be used with caution if policymakers are dealing with an issue for which the public wants to be confident of results. Although information reporting may be required, the participating firms are not usually required to reduce their pollution. For example, neither the TRI nor 33/50 programs required firms to reduce or even change their pollution discharges in any way. Firms may voluntarily cooperate for a range of reasons, including the hope that they will benefit from an improved public image or by avoiding otherwise mandatory regulations. Yet without the requirement that firms reduce pollution, the public can not be confident that environmental progress will result.

Similarly, most subsidy programs are offered on a voluntary basis, although they could be conditioned on the recipient's making pollution reductions. Technical assistance programs also do not typically require firms to participate and, even when they do participate, do not require them to accept the recommendations or changes proposed.

Pollution Prevention

- ● ***Effective: Product bans, technical assistance***
- ◐ ***It depends: Technology specifications, design standards, liability***
- ▽ Use with caution: —

If pollution prevention is a priority. technical assistance is one of the few tools that can be relied on to tip the scales in a firm or industry toward pollution prevention strategies. Usually targeted at small firms, technical assistance programs have been very effective in other policy areas, notably agriculture, in promoting and securing changes in technical practices. To date, however, the level of resources allocated to a delivery system for pollution prevention assistance has been very small in comparison to the overall environmental protection effort in the United States and to the investments in the agricultural extension services delivery system since the late 1800s.

A **product ban** can, of course, be quite effective in eliminating the product as a source of pollution in the future, although that action would not address damages from past uses. However, such initiatives are used very sparingly, at least under the three major statutes addressed in this report.

Design standards or **technology specifications** have been criticized as perpetuating a preference for end-of-pipe technologies rather than for prevention approaches. Yet there is no reason why they could not describe a pollution prevention approach for meeting the standard, thus creating a highly effective tool for encouraging industry to adopt such practices.

Environmental Equity and Justice

- ● **Effective:** ***Information reporting, subsidies, technical assistance***
- O **It depends:** —
- V **Use with caution:** ***Traceable emissions, challenge regulations, pollution charges***

Many of the issues associated with environmental equity and justice are related to institutional reforms rather than instrument choice. Thus, although these issues are of central importance to environmental policy, with few exceptions the policy instruments seem unlikely to be particularly helpful or particularly harmful in promoting them. **Information reporting, subsidies,** or **technical assistance,** however, are able to improve the level and quality of information and provide financial support for a range of activities, such as education, research, or funding for health diagnostic clinics and site cleanups to assist minority and low-income communities.

Instruments such as **tradeable emissions** and **challenge regulations,** which do not tie a specific level of pollution reduction requirements to a particular facility or source, and **pollution charges,** which allow facilities to pay rather than control emissions, have the potential to exacerbate concerns over adverse or unequal effects of exposures for specific types of individuals or communities near the facilities.

■ Change

Over the past 25 years, we have continually adopted environmental policies as if they were the final solutions to temporary problems. Yet we are still struggling with much the same set of environmental problems—and more. By establishing **policies** that lack *adaptability* to change, the United States has created barriers to responsive policies and innovative solutions. In addition, although costs are a limiting factor for many industries, for others the speed with which they are able to act on opportunities for *technology innovation or diffusion can be* critically important for their competitiveness.

Adaptability

- ● **Effective:** ***Liability, information reporting, technical assistance***
- O **It depends:** ***Challenge regulations***
- V **Use with caution:** ***Product bans, technology specifications, design standards***

Almost none of the instruments, once implemented as a formal program, is easy to modify. Criticism of the rigidity of regulatory instruments usually reflects the administrative requirements and associated agency norms for rulemaking and case-by-case review of facility changes. This rigidity is by no means unique to environmental regulations; rather, it stems largely from a body of legal requirements known as administrative law, which governs all federal executive agencies.

Developed to provide due process to parties affected by agency actions with the effect of law, these procedural requirements can create enough delays to make all parties-the agencies, the public, and the regulated sources—frustrated and somewhat reluctant to modify programs. Efforts to reform these types of requirements have varied widely, depending on the origin of the initiatives—some reformers want to lessen the regulatory red tape and others want to increase the red tape. For example, targeted groups often prefer clear, stable program requirements that allow them to develop a compliance approach that does not need frequent modification. Yet they may also want to be able to modify their choice rather quickly when opportunities or competition make such changes imperative.

One approach Congress could consider is to match the strategy to the instrument in a way that lessens the likelihood of needing modification. For example, **harm-based standards** easily accommodate rapidly changing technologies that may improve performance or reduce costs of compliance. Firms are free to adopt or not adopt them without securing agency approval. However, if new information suggests that a pollutant is more of a threat than previously believed, changing the harm-based standard itself can be slow and cumbersome.

Similarly, if Congress establishes a **design standard** and new technologies appear on the market rather rapidly, use of the new technologies might be slowed by the time and effort required to revise the rule describing the model technology, unless facilities can easily demonstrate "equivalency." If the model technology has been written into the facility's permit, then a permit revision might be required if the facility would like to install the new technology.

Only a few instruments seem resilient. **Liability** provisions, for example, once written into statutes would usually not require modification. The courts have the task of adapting the provisions to specific cases. **Information reporting** and **technical assistance** programs can usually be modified by the agency to accommodate changing needs, although statutes may restrict use of funds or targeted industries.

Technology Innovation and Diffusion

- ● **Effective:** ***Product bans, pollution charges***
- O **It depends:** ***Tradeable emissions, challenge regulations***
- v **Use with caution:** —

Theory and evidence about the link between technology innovation and environmental regulation suggests instruments themselves are not as important as other factors such as the *stringency of* the goal, the *reasonableness of milestones* for compliance, and the *certainty* that everyone must comply. Most of these issues cannot be addressed directly by policy instruments; however, several of the instruments offer some possibility of changing the odds to favor innovative responses by firms.

Product bans or limitations, for example, can be very effective at forcing innovation, even though they are the most restrictive tool, because they have the potential to disrupt markets. If substitute products are not readily available, firms are likely to innovate to fill the void. Of course, as we discussed earlier, this strategy could be very costly and thus is seldom used under the statutes included in this report, although it is used more frequently to implement FIFRA and TSCA. A quite different approach, pollution charges leave firms completely free to innovate if they wish to do so. Charges are effective because, even when it firm emits at what might be considered an acceptable level, it still must pay a fee. Thus pressure to innovate to lower emissions remains until emissions drop to zero.

In addition, any of the instruments that fix targets for multiple sources rather than individual sources allow firms or facilities an opportunity to decide for themselves whether they want to innovate or use an off-the-shelf solution. **Challenge regulations** and **tradeable emissions--especially** if designed with longer, more flexible implementation schedules and permitting protocols---could improve the likelihood of investments in innovative technologies.

We actually know much more about how these instruments might affect diffusion of existing, but not widely used, technologies. For example, those instruments that require or create a preference for a technology--some design standards and technology specifications–-and product limitations and bans can be very effective at diffusing a technology. Subsidies and technical assistance can also be useful in promoting adoption of known technologies.

However, **technical assistance** presents a potential tradeoff for policymakers. While it can be an excellent way to diffuse known technologies, especially within small firms, technical assistance programs supported by the government may at times compete with the environmental goods and services industry efforts to innovate and sell innovative products and services to industries.

CHOOSING TOOLS

Finding the best tool for managing or resolving a specific environmental problem is a complex undertaking. So far, we have provided a primer describing each of the 12 policy instruments and each of seven criteria, with examples to illustrate our points.

Box 1-2 provides four examples of how these criteria can help policymakers assess the potential effectiveness of instruments for implementing current programs. In each case, we use several key criteria to highlight issues raised by the particular tool or set of tools chosen for implementation. Chapter 2 discusses these examples in greater detail.

However, a policymaker who must actually choose an instrument to deal with a pressing environmental problem is likely to need more than definitions and case studies. In this section, we get down to the business of offering a more systematic framework for considering how to match these instruments to a particular problem, given the values and interests at stake. We follow this with a discussion of several stumbling blocks preventing us from making full use of the complete set of tools considered in this report.

We begin with the threshold question: ***Who chooses?*** Does Congress prefer to make the choice of instrument itself or delegate the choice to the states or localities? Over the past 25 years, Congress has typically specified the approach itself, but not always. Nor can we assume that this pattern will prevail.

Once this choice is made, the hard part begins. Whether it is Congress or state decisionmakers, someone is faced with the difficult task of ***matching tools to problems***. We present a two-part framework that begins by first ***narrowing down the choice of instruments*** based on how they perform on each of the seven criteria. Because there is often no perfect match of instrument to problem, we also discuss bolstering the weaknesses of any single tool by ***using more than one instrument.***

Although but one option appears to be presented in this part of the report—that is, the framework for matching tools to problems—working through the framework when choosing tools creates hundreds of possible options or combinations of several instruments at a time. This framework can help Congress narrow down the choice from the many possible to an acceptable few. In addition to serving its primary purpose of helping Congress to match tools to specific environmental problems, the framework also allows Congress to **evaluate the implications** of specific policy proposals. Once again, the seven criteria form the basis for this evaluation.

Throughout our research, we identified a series of ***stumbling blocks that limit the use of potentially desirable tools***, that is, instruments that offered advantages, for example, for cost savings for industry, government, or both. These stumbling blocks are at least part of the reason why, to date, we have primarily relied on a small subset of the available tools. Though many in Congress would prefer a more risk-based approach to environmental regulation, our poor understanding of risk makes this difficult at this time. Similarly, both government and industry recognize the advantages of performance-based regulations, but the lack of monitoring technology often stands in the way. Finally, our limited experience with some policy tools itself becomes the reason for staying with well-tried, though imperfect, methods. We close this section with a set of actions to help remove each of these three stumbling blocks.

Who Chooses?

Although OTA has prepared this primer for Congress, pollution abatement is clearly an intergovernmental issue. States and localities play a

BOX 1-2: Case Studies: Tools, Criteria, and Key Issues

Tradeable Emissions

RECLAIM, Los Angeles area:

Cost-effectiveness and fairness: As reductions to meet air quality standards became increasingly expensive under the previous control plan, both industry and government began searching for ways to lower emissions more cost-effectively, The perception of what is a "fair" initial allocation of permits and a fair rate of reductions differed among stakeholders.

Assurance of meeting goals: State-of-the-art monitoring was a crucial component for ensuring that individual sources were accountable for reductions and that the program could be enforced. This ultimately limited the types of sources that could participate.

Environmental equity and justice: Public interest groups were concerned that trading might lead to higher ozone levels in predominantly Black and Hispanic areas, compared with levels under the source-specific program it replaced.

Integrated Permitting

New Jersey;

Pollution prevention: The program requires formal facility-wide pollution prevention planning as a condition for integrated permitting,

Adaptability: The integrated permit incorporates a range of acceptable changes, allowing a facility to quickly make process changes in response to market opportunities without needing additional agency approvals.

Information programs

Proposition 65 and "Hot Spots'' program, California:

Assurance of meeting goals: Although both programs establish incentives for lowering exposures to toxics, neither provides much assurance to the public that goals will be met. The "Hot Spots" program was amended several years later to require reductions,

Pollution prevention: Proposition 65 assumes that consumers will reject products using toxics, thus pressuring companies to prevent pollution by finding substitutes,

Environmental equity and justice: Giving communities or individuals information about risks or about emissions can improve their ability to identify potential dangers. Both programs report risk—as opposed to emissions asunder the federal Toxics Release Inventory—an easier measure for the public to interpret,

Technical Assistance

Toxics Use Reduction Act, Massachusetts:

Adaptability to change: A service unit oriented toward client needs can incorporate changes in these needs and modify its practices in response to information about new technologies or changed understanding of risk rather easily in comparison to other types of instruments.

Technology innovation and diffusion: A focus on small firms without R&D capability and efforts to link experts can facilitate diffusion and might improve chances for innovation. Institutional and geographic separation of a state's R&D group from its outreach group may diminish opportunities for learning and cross-fertilization of ideas.

SOURCE: Office of Technology Assessment, 1995.

central role in protecting human health and the environment, implementing both federal laws and their own statutes and programs. In the three federal statutes considered in this report, cities and counties, special districts, states, and the federal government all participate in delivering programs to achieve goals.

Thus, one question Congress may want to consider as it tries to match tools to problems is: Who should choose? Should Congress make the choice itself, delegate the choice to EPA or to the states and localities, or shift the responsibility to the private sector? Such a choice will of course be both political as well as administrative in nature. A preference for federal rather than state or private responsibility for choosing might be based on opinions about the states' willingness or administrative capacity to provide the level of protection Congress wants. Or the desire to let someone else choose might be restrained by considerations of cost-effectiveness—for example, an industry-wide information program might be more efficiently run at the national level with information-sharing to all levels of government as well as the public.

Over the past 25 years, Congress has usually chosen the policy tools for implementing environmental programs, although sometimes it has deliberately given the responsibility for choosing the means to others, including the EPA, the states, and localities. Congress has not yet tried giving responsibility for choosing policy tools to the private sector, but earlier in this report OTA described a policy tool—challenge regulation—that would allow federal or states agencies to do exactly that.

When delegating responsibility for choosing policy tools to states, Congress has typically retained at the federal level the authority to disapprove state choices. The State Implementation Plan (SIP) process, for example, established by the Clean Air Act, delegates responsibility to states to develop the approaches they wish to use to attain environmental goals. Although Congress sets some parameters, such as "reasonably available control technology" (RACT) and other design standards as a minimum level of control, states are free to select any tool they wish to accomplish additional air quality gains. For example, the RECLAIM program in Southern California uses tradeable emissions as one of the primary tools for improving regional air quality.

The Clean Water Act gives states similar opportunities to make tool choices. Although states must use the national minimum levels of pollution control set by design standards, where more control is needed to meet goals, states are free to select any means they wish. These choices may vary greatly among states. Although most states have adopted harm-based standards, Wisconsin, for example, chose to take a multisource approach by building a trading option into its requirements.

The nonpoint source provisions of the Clean Water Act establish *no* preference for policy tool, giving states the responsibility for developing a program. Most states have chosen a combination of voluntary technical assistance and subsidy programs.

Matching Tools to Problems

In this section, we present a two-part framework that helps policymakers first *narrow down the choice of instruments* based on how they perform on each of the seven criteria and then, if needed, helps them *buttress weaknesses of any single tool by using more than one instrument.*

We begin by summarizing OTA's judgments about how each of the instruments performs on the criteria presented in the previous section. The purpose of making these judgments is to draw the decisionmaker's attention to instruments that might be particularly effective or might warrant caution in some instances. Of course, these judgments are obviously generalizations of how each policy tool is likely to perform on a "typical" environmental problem. Only when considering the specifics of a problem can the strengths and weaknesses of a particular approach be determined with confidence.

We pose a series of questions about the particular problem, the answers to which—in combination with the important criteria—may point to one set of instruments rather than another. These questions include the following: Given a pollutant, the quantities and location of its releases, and the characteristics of its sources, is there a reason to specify a fixed environmental target? If so, do these targets need to be source specific? Are we likely to be particularly concerned about costs and burdens to industry or government? Do we anticipate or hope that tomorrow's understanding of this problem or its solution will be significantly different than today's?

After working through these questions, a decisionmaker might find the perfect instrument for dealing with the problem. However, he or she is just as likely to be faced with a tradeoff between wanting to use one instrument that provides assurance to the public and another that might spur innovation. In these situations, the common approach is to choose a combination of instruments that compensates for the weaknesses inherent in any single approach.

In fact, much of current environmental policy is based on using multiple instruments, as we saw in an earlier section. For example, a rather simple instrument may be preferred in the beginning to make fast progress, followed by the implementation of a more complex but also more precise approach resulting in greater cost-effectiveness. In other situations, a single-source instrument like harm-based standards might be needed to handle a problem of local scale, with associated regional or national problems mitigated through a multi-source instrument.

Narrowing Down the Choice of Instrument

Table 1-5 summarizes how each of the instruments stacks up against the seven criteria. Again, since the evaluations shown in the table are obviously generalizations of how each policy tool is likely to perform on a "typical" environmental problem, exceptions are plentiful. Yet, by highlighting those instruments which, as a general rule, could be effective in achieving a criterion, or those which are best used with some caution, the table can help decisionmakers effectively match an instrument to an environmental problem.

Our evaluations of each instrument are relative—for each criterion, we compare each instrument relative to all the other instruments addressed in the report. Thus, by definition, most instruments will be about average in performance for a particular criterion—and identified with a small dot on the table. We indicate when a tool is likely to be particularly effective with respect to one of the criteria (shown with a filled-in circle) and when Congress should be cautious about whether the approach will achieve the criterion (shown with a caution triangle). Note that "caution" does not always mean "inappropriate," but that extra care must be taken when designing and implementing a program using this tool, if the criterion is of particular importance.

The table also includes some judgments of "it depends" (shown with a partially filled-in circle), when the performance of the instrument is particularly dependent on the specifics of implementation or the characteristics of a problem. The instrument might either be effective or about average with respect to that criterion, depending on the specific situation, but is not likely to be a poor choice.

The three categories of instruments and the instruments themselves are roughly ordered in table 1-5 according to the relative decision-making responsibility given to government versus left with sources being directed or in some way encouraged to change behavior. At the top of the table are the tools that move behavior in the right direction but do not specify fixed targets. The bottom two categories include the policy tools that directly limit pollution, the first by specifying environmental targets for groups of sources and the second by specifying targets for single sources.

Just how much responsibility for decisionmaking remains with sources versus how much is given to EPA or the states is one of the most important questions for choosing a policy instrument. We assume that Congress will prefer to leave as much flexibility and autonomy as possible in the hands of those whose behavior it wishes to change. If

TABLE 1-5: Narrowing the Choice of Policy Instruments

	Environmental Results		Costs and Burdens		Change	
	Assurance of meeting goals	Pollution prevention	Cost-effectiveness and fairness	Demands on government	Adaptability	Technology innovation and diffusion
Tools *without* fixed targets						
Technical assistance	∇	●	O	•	●	•
Subsidies	∇	•	•	∇	•	•
Information reporting	∇	•	O	●	●	•
Liability	•	O	•	•	●	•
Pollution charges	•	•	•	•	•	●
Tools *with* fixed targets—multisource						
Challenge regulations	•	•	∇	O	O	O
Tradeable emissions	O	•	●	•	•	•
Integrated permitting	●	•	•	O	•	•
Tools *with* fixed targets—single-source						
Harm-based standards	●	•	•	∇	∇	•
Design standards	●	O	•	•	•	∇
Technology specifications	●	O	∇	•	•	∇
Product bans	●	●	∇	•	•	∇

● = Effective O = It depends ∇ = Use with caution • = Average

NOTE These ratings are OTA's judgments, based on theoretical literature and reports of instrument use. The evaluation of each instrument on a particular criterion is relative to all other instruments. Thus, by definition most instruments are "average. ""Effectwe" means that the instrument is typically a reliable choice for achieving the criterion. "It depends" means that it may be effective or about average, depending on the particular situation, but it is not likely to be a poor choice And "use with caution" means that the instrument should be used carefully if the criterion is of particular concern.

SOURCE: Office of Technology Assessment, 1995.

there are no societal gains to be had by removing flexibility and autonomy, there is no reason for Congress to do so.

There are, however, many good reasons why Congress has limited, and will continue to choose to limit, the discretion of sources in some way. Again, this report does not address the question of setting goals—that is, what pollutants to regulate and how stringently. But once an environmental problem has been identified as worthy of governmental intervention, Congress must also decide *how* government should intervene-that is, what policy instrument or instruments seem best suited given the characteristics of the problem and the values and beliefs of the decisionmaker.

By asking key questions about a problem outlined in box 1-3, Congress can at least narrow the choice from a dozen to a few appropriate choices of policy instrument. These key questions follow: *Given a pollutant, the quantities and location of release, and the characteristics of the sources,*

BOX 1-3: Key Questions for Matching Policy Tools to Problems

- ***Given the pollutant and the quantities and location of release, is there a reason to specify a fixed environmental target? If so, do these targets need to be source specific?***
  1) How harmful or risky is the pollutant in the quantities that are being released?
  2) Is this problem typically quite localized or regional in nature?
  3) Does the technology exist to monitor the pollutant at a reasonable cost?
- ***Given the pollutant and its sources, are we likely to be particularly concerned about costs and burdens to industry, individuals, or government?***
  1) Are the sources of the pollutant reasonably similar or do they vary considerably from source to source even within industrial categories?
  2) Are there large differences in control costs among sources?
  3) Are there either very many sources or very few?
  4) Do we just not know very much about how to control the problem, the costs of control, or how to set environmental targets?
- ***Given the pollutant and its sources, do we anticipate or hope that tomorrow's understanding of this problem or its solution will be significantly different than today's?***
  1) Is our uncertainty about the nature of the risk relatively high? Are the environmental goals very much in flux or are they likely to remain fixed for a reasonable period of time?
  2) Is technology changing rapidly, either the technology to prevent or control pollution or technologywithin the industry or sector itself?
  3) Can we achieve congressional environmental goals with today's technology at an acceptable cost?

SOURCE: Off Ice of Technology Assessment, 1995.

- *Is there a reason to specify a fixed environmental target?*
- *If so, do these targets need to be source specific?*
- *Are we likely to be particularly concerned about costs and burdens to industry, individuals, or government?*
- *Do we anticipate or hope that tomorrow's understanding of this problem or its solution will be significantly different than today's?*

How do these questions, along with the judgments presented in table 1-5, help one choose an appropriate policy instrument? First, we must be clear in saying that there is no indisputable procedure that will clearly lead to one choice or another. Each decisionmaker will weigh the importance of each of the criteria in the table differently. And the choices one makes when answering each of these questions may have to be rethought and revised when subsequent questions are asked.

The place to begin is at the top of the table, with the instruments that leave the greatest decision-making responsibility in the hands of sources. Again, we are assuming that, unless there are good reasons to do otherwise, Congress will prefer to leave as much flexibility and autonomy as possible with those whose behavior it wishes to change.

The tools at the top of the table are those that move behavior in the right direction, but do not specify fixed targets. Thus, within this category, the sources themselves choose the level to which they control or prevent pollution. Technical assistance programs and subsidies are typically completely voluntary; sources are offered "carrots" to participate, but participation remains voluntary. Under the next three instruments-information reporting, liability, and pollution charges——— sources are subject to government regulation or requirements, but the degree to which they respond with actual abatement results is up to them.

The first question in this framework asks, ***Is there a reason to specify a fixed environmental target for this pollutant?*** To answer this, one needs to know how harmful or risky the pollutant is in the quantities that are being released. If there is a reason to limit releases—for example, because of potential harm—then a criterion that may be very important is "assurance of meeting goals."

The first column to the left on table 1-5 displays our judgments of the "assurance" provided by each of the instruments. Not at all surprising, those in the first category, that is, those without fixed targets, are marked with a caution. One cannot say that goals will not be met—there are instances in which these instruments have been quite effective in the past—only that there is increased uncertainty. Thus the first question to answer is whether, given the magnitude of the problem, the increased assurance of meeting environmental goals is a fair trade for "jumping the line" to the next categories of instruments. Obviously other factors—such as costs of control and difficulty of setting targets—enter into the decision, which we will come back to later. But first, we will consider those cases where Congress does wish to set fixed targets.

If one prefers a fixed environmental target, the next question to ask is, ***Does this target need to be source specific?*** The bottom two categories include the policy tools that directly limit pollution, first by specifying environmental targets for aggregates of sources, and finally by specifying sources for single sources. Again, when targets are specified for groups of sources—entire facilities rather than individual emission stacks or discharge pipes—or by capping emissions over an entire region, more responsibility for decisionmaking remains in the hands of those being regulated than with government. Individual sources can either be controlled to their share of the total or arrange for another source to fulfill their responsibility.

But only some environmental problems are regional in nature. Urban ozone and acid rain are two that are regional and thus are logical choices for regulatory programs that allow marketable emissions. Both are pollution problems that result from the cumulative emissions of sources over at least a city, a multistate region in the case of smog in the Northeast, to even larger multistate areas in the case of acid rain.

For problems that are local in nature—e.g., exposure to some toxic air pollutants—many will judge multisource instruments to be inappropriate. If one of the environmental goals is to reduce exposures to the most exposed individuals, in contrast to lowering regional average exposure, then regional multisource instruments may not be effective. To achieve this type of goal, the single-source instruments in the last category may be more appropriate, though integrated permitting—a multisource approach confined to one facility—may be adequate.

Another question that may lead one to prefer a single-source approach is, *Does technology exist to directly monitor the pollutant?* Existing air pollution trading programs for acid rain and urban ozone rely on either continuous emissions monitoring or a sophisticated tracking system, so that the program is enforceable in court. But even here, at least in one case, the program has been constrained by difficulties in monitoring. In a proposed trading system in the Los Angeles region for volatile organic compounds—one of the pollutants that leads to the formation of ozone—several source categories (for example, petroleum refineries) have been excluded and will be regulated source by source. Once again, multisource instruments can certainly still be used in situations in which monitoring capabilities are not well developed, but the increased flexibility to sources will come at the price of some loss of assurance that environmental goals are being met.

In the last category—single-source tools with fixed targets—the government's role is greatest although, even within this category, variation exists in the relative decisionmaking responsibilities of government and sources. Harm-based standards specify end results, typically in terms of the quantity of pollution being emitted. Sources are free to choose the method they use to achieve the end result. Technology specifications, though rarely used, in some way specify the means, or at least limit the ways the results can be achieved. Design standards fall somewhere in between. They are based on a reference technology, which sometimes is perceived as a technology specification by either sources or government permit writers but most often is expressed in the same way as a harm-based standard—that is, the desired performance or end results.

The desire to allow sources to retain as much autonomy as possible leads one to instruments higher up in table 1-5; the desire for greater assurance pushes one farther down. If these were the only concerns, the choice of instrument would be reasonably straightforward, though the results of this tradeoff would vary from decisionmaker to decisionmaker. However, as we saw in an earlier section, many other concerns complicate the decision. Foremost among these are concerns for ***costs and burdens to industry and government.***

While it is generally true that increased autonomy to sources can improve the cost-effectiveness and fairness of pollution prevention or control, this is not always the case. Leaving decisionmaking in the hands of sources sometimes decreases the costs and burdens to government, but in other instances can increase government burden. Multisource instruments such as integrated permitting and tradeable emissions can be more expensive for government than design standards because the increased flexibility for sources may have to be matched with greater government effort to keep the same level of assurance that goals will be met.

But again, the judgments presented in table 1-5 are of necessity generalizations that can provide but rough guidance. By understanding the specifics of the pollutant and its sources one can gain further insight into the performance of a particular policy approach. Questions worth asking include *Are the sources reasonably similar? In particular, are there large differences in control costs among sources? Are there either very many sources or very few?*

The vast majority of programs established under the Clean Air Act, the Clean Water Act, and the Resource Conservation and Recovery Act have been based on single-source instruments. By and large they have been quite successful, but there have been pockets of failure. When costs are quite variable from source to source, single-source instruments can result in higher control costs than necessary. A move to multisource instruments can result in lower assurance that goals will be met and greater difficulty for government, but it still may be worth it.

Another judgment one needs to make is *Do we know much about how to control the problem, the costs of control, and how to set environmental targets?* For example, a potentially risky pollutant that one might otherwise wish to control with a harm-based standard may be so poorly understood that a different choice might be in order. One could move down the table to the simpler design standard, recognizing that the analytical difficulty of determining the level of environmental quality needed to set harm-based standards can be much greater than identifying available methods of control. If the burdens to government are too great, the program may never get off the ground. This is the reason that the harm-based toxic air pollution program established by the original Clean Air Act was changed to one based on design standards in the 1990 Clean Air Act Amendments.

Similarly, the number of sources can affect the feasibility of using some instruments. Too many sources can doom a program based on harm-based standards. Too few sources may limit the cost advantages from emissions trading.

If we just do not know very much about how to control the problem or how to set environmental targets, the choice might be to move well up the table to a directionally sound instrument such as information reporting or technical assistance. In the Toxics Release Inventory, established by the Superfund Amendments and Reauthorization Act of 1986, Congress followed the latter approach (four years earlier for many of the same toxic air pollutants addressed by the Clean Air Act Amendments of 1990). Since the reporting began in 1988, air emissions have dropped by about one-third.

There is one more related concern that may alter one's choice of instrument. ***Given the pollutant and its sources, do we anticipate or hope that tomorrow's understanding of this problem or its***

solution will be significantly different than today's?

If the uncertainty about the nature of the risk is relatively high or if technology is changing rapidly, one might be drawn to instruments that are most adaptable to change. A few of these allow sources to make changes without government approval and can be easily modified by government when the need arises. Technical assistance programs, information reporting, and liability—all directionally sound instruments that avoid rulemaking—are most effective on this concern.

If for a particular problem, environmental goals cannot be achieved with today's technology at an acceptable cost, one might choose instruments that spur technology innovation. Pollution charges are among the best choices because of the continuing pressure they exert. Product bans are also effective at spurring innovation, but in situations in which alternatives are not available, Congress may wish to use such an approach only when the risks from the pollutant are thought to be high. Multisource instruments such as tradeable emissions or challenge regulations offer additional opportunities for using new technologies and thus may also be quite effective in encouraging innovation. One might be faced with a tradeoff between wanting to use a single-source instrument such as a design standard for assurance and simplicity and the desire to spur innovation so that tomorrow's technology will be better than today's.

Using More Than One Instrument

It is rare when one instrument alone satisfies all of the desires that policymakers may have in attempting to solve an environmental problem. Thus we find historically a reliance on the use of multiple instruments when addressing a problem. Table 1-2 presented the primary policy instruments under each of the approximately 30 pollution control programs addressed by the CAA, CWA, and RCRA. The categories of programs listed in the table are by and large based on the type of distinctions discussed in the previous section:

- the *types of pollutants*, for example, whether the program addresses ubiquitous pollutants, such as "conventional" water pollutants and "criteria" air pollutants, or toxic or hazardous pollutants addressed by all three statutes;
- the *severity of the problem*, that is, whether the source is located in an area that already meets or does not meet minimum environmental quality goals; and
- the *sources of pollutants*, whether the discharge is from the industrial or some other sector, whether the sources are existing or new, and so on.

The single most common combination is the use of design standards in conjunction with harm-based standards. About half of the categories that we have defined follow this approach to control. Control of conventional water pollutants, such as biochemical oxygen demand (BOD) materials and suspended solids, is typical of this combination. For water bodies that meet the desired level of water quality set by each state, sources that discharge directly into lakes and streams are required to control to a level defined by a **design standard** specific to each source category and pollutant. Municipal sewage treatment plants are required to control to a level equivalent to "secondary treatment," and industrial dischargers must control equivalent to "best available technology economically achievable."

However, if the water body does not meet the desired level of water quality, sources are subject to a **harm-based standard,** that is, sources are required to clean up their effluent to a level that allows the lake or stream to maintain the specified water quality. The simpler design standard becomes a "floor" or minimum level of control; however, if the desired water quality is not achieved, the more analytically complex harm-based standard then applies. As will be discussed below, this mix of instruments is a compromise allowing the relative speed, simplicity, and lower administrative burden of design standards in cleaner areas and the potential for more efficient controls using a harm-based approach in areas where more stringent and expensive controls are needed.

As is also shown in table 1-2, design standards used to control toxic pollutants have been frequently regulated by pairing them with two other instruments, **liability** and **information reporting** requirements. The CWA uses liability in combination with either paired design standards and harm-based standards or design standards alone to control toxic water pollutants. Information reporting such as requirements under the Toxics Release Inventory (TRI) is part of the control strategy for toxic pollutants under all three statutes; however, TRI is limited to the manufacturing sector alone.

Several problems addressed by the CAA combine **tradeable emissions** with more traditional single source approaches. To date, these have primarily been limited to emissions of pollutants such as sulfur dioxide and nitrogen oxides—pollutants whose effects are regional as opposed to the more localized impacts of toxic air pollutants. For example, trading has been extensively used to allow new sources to locate in nonattainment areas, that is, areas that do not meet ambient air quality standards. New sources can locate in nonattainment areas if they "offset" their emissions with reductions from existing sources. Another area in which trading has been used is for complying with exhaust emission standards for heavy-duty diesel engines. Rather than requiring all engines to meet identical emission standards, manufacturers are allowed to design some models to emit more and some less, so long as emissions from all heavy-duty diesel engines in each model year remain the same.

Table 1-6 returns to consideration of the seven criteria that this study uses to examine the strengths and weaknesses of alternative policy instruments. The table repeats the "overall" evaluation for each criterion as it applies to each instrument, presented in table 1-5. Each of the criteria are further divided into several components that can help us understand how multiple instruments can be used to satisfy multiple goals.

Again, the most frequently chosen regulatory approach is a **design standard** in combination with a harm-based standard. We rate both instruments about the same for cost-effectiveness and fairness of control, but design standards have an edge when it comes to demands on government. The key difference is the ease of analysis. For example, the difficulty of setting harm-based standards was probably the primary reason for the slow pace of regulating air toxics emissions since the 1970s, which led Congress to change strategy in the 1990 Clean Air Act Amendments. As discussed earlier, Congress abandoned a strategy based primarily on the use of harm-based standards and adopted an approach that directs EPA to first issue a design standard (emissions equivalent to those achieved by using "maximum achievable control technology") and then analyze whether "residual-risk" goals are exceeded and, if so, to require additional controls. Thus, by using a multi-source approach, Congress attempted to buttress the weaknesses of harm-based standards with the simpler approach of design standards.

Both the single-source design and harm-based standards are merely average with respect to efficiency and fairness of control, although harm-based standards are probably the better of the two. Hence the great attention given to multisource instruments, which have the potential for improved cost-effectiveness. As can be seen in table 1-6, we rate multisource instruments such as **tradeable emissions** and **integrated permitting** (which in our definition includes facility-wide "bubbles" or emission caps) as potentially more cost-effective. It is for this reason that EPA is encouraging states to adopt "open market" trading programs to augment current air pollution control programs in nonattainment areas. The programs in most nonattainment areas are currently based on a combination of design and harm-based standards. Open market trading programs allow sources with the ability to control emissions to a greater extent than required to do so and sell these reductions to other sources.

Multisource instruments also offer additional incentives for technology innovation, as shown in the last few rows of table 1-6. Note, however, that tradeable emissions and integrated permitting are marked with a "caution" for costs to government. While such programs are still quite new and thus

TABLE 1-6: Strengths and Weaknesses of Policy Instruments

● = Effective
O = It Depends
v = Use with caution
• = Average

		Fixed Target: Single-source: Product bans	Fixed Target: Single-source: Technology specifications	Fixed Target: Single-source: Design standards	Fixed Target: Single-source: Harm-based standards	Fixed Target: Multisource: Integrated permitting	Fixed Target: Multisource: Tradeable emissions	Fixed Target: Multisource: Challenge regulations	No Fixed Target: Pollution charges	No Fixed Target: Liability	No Fixed Target: Information reporting	No Fixed Target: Subsidies	No Fixed Target: Technical assistance
Costs and burdens	**Cost-effectiveness and fairness**	∇	∇	•	•	O	●	O	•	•	O	•	O
	Cost-effectiveness for society	∇	∇	•	•	•	●	O	●	•	O	∇	•
	Cost-effectiveness for sources	∇	∇	•	•	0	0	0			0	0	0
	Fairness to sources	∇	∇	•	•	•	●	●	∇	∇	•	•	•
	Administrative burden to sources	•	•	•	•	∇	∇	∇	•	∇	•	•	•
	Demands on government	•	•	•	∇	•	•	O	•	•	●	∇	•
	Costs	•	•	•	∇	•	•	O	•	•	●	∇	•
	Ease of analysis	V	•	•	V	∇	O	O	∇	•	•	•	•
Environmental results	**Assurance of meeting goals**	*	*	*	*	●	O	•	•	•	∇	∇	∇
	Action forcing	●	0	●	0	●	●	O	•	•	∇	∇	∇
	Monitoring capability	●	0	0	•	O	∇	∇	∇	∇	•	•	•
	Familiarity with use	•	∇	●	●	•	•	∇	∇	•	●	●	●
	Pollution prevention	●	O	O	•	•	•	•	•	O	•	•	●
	Gives prevention an advantage	●	O	O	•	O	•	•	•	O	•	O	O
	Focuses on learning	•	∇	∇	∇	•	•	O	•	O	O	•	●
	Environmental equity and justice	•	•	•	•	•	∇	∇	∇	•	●	●	●
	Distributional outcomes	.	•	•	●	•	∇	∇	∇	•	•	•	•
	Effective participation	•	•	.	•	•	∇	∇	∇	•	●	●	●
	Remediation	.	•	.	.	•	•	•	•	●	•	●	●
Change	**Adaptability**	∇	∇	∇	•	•	•	O	•	●	●	•	●
	Ease of program modification	∇	∇	∇	∇	∇	∇	•	∇	●	●	O	●
	Ease of change for sources	∇	∇	∇	•	O	●	●	●	●	●	•	●
	Technology Innovation and diffusion	●			*	•	O	O	●	•	•	•	•
	Innovation in regulated industries	●	∇	∇	•	•	O	O	●	•	•	•	•
	Innovation in EG&S industry	•	∇	●	•	•	0	0	●	.	.	•	∇
	Diffusion of technologies	•	●	●	.	•	•	•	●	•	•	●	●

NOTE: These ratings are OTA's judgments, based on theoretical literature and reports of instrument use. The evaluation of each Instrument on a particular criterion is relative to all other instruments Thus, by definition most instruments are "average." "Effective" means that the instrument is typically a reliable choice for achieving the criterion "It depends" means that it maybe effective or about average, depending on the particular situation, but it is not likely to be a poor choice. And "use with caution" means that the Instrument should be used carefully if the criterion is of particular concern

SOURCE: Office of Technology Assessment, 1995.

current demands on government may not be representative, the costs to implement these multisource instruments have been greater than expected.

Ideally one would like to choose a mix of instruments that achieved high marks on all seven of the criteria considered in this study. Because the instruments that are directionally sound but without fixed targets provide little assurance of meeting environmental goals, they have been used alone infrequently. However, they are extremely helpful when combined with other instruments. For example, **technical assistance** programs are one of the most effective approaches for encouraging pollution prevention. Programs that give technical assistance to help the community understand the impacts of existing or proposed sources can also help to achieve environmental justice goals.

Environmental justice goals can also be advanced through **information reporting** programs. As mentioned above, the TRI augmented existing regulatory programs for toxic pollutants under the CAA, CWA, and RCRA. Such information allows the community, regulators, and even corporate decisionmakers to better understand the risks posed by each manufacturing facility. If firms choose to lower emissions as a result of the information disclosure program, they are of course free to choose the most cost-effective method. The costs to government for the additional reductions are also typically quite low.

Stumbling Blocks That Limit the Use of Desirable Tools

Unfortunately, in many instances policymakers may find they are unable to use the instrument they want to choose, or at least to use it as effectively as possible in a particular situation, because of stumbling blocks. Some of these stumbling blocks are institutional, for example, poorly written facility permits. These kinds of problems might be addressed in a variety of ways, including providing professional education and in-service training and increasing information sharing by the federal, state, and local governments (126,127, 207). Others will require improvements in scientific and technological capabilities. In this section, we consider three stumbling blocks that we judge to be particularly important:

- inadequate scientific foundation on which to make quantitative estimates of the relationship between pollutant emissions and human health and ecological impacts,
- an absence of accurate, reasonably simple, and affordable monitoring technologies to measure pollutant output, and
- a lack of experiences using many of the tools and, consequently, our poor base of information about their performance.

The rather poor state of scientific understanding of the transport, fate, and effect of many pollutants often deters congressional efforts to increase our use of risk-based strategies for environmental protection. Risk-based strategies are particularly desirable because the instruments associated with them—harm-based standards for single sources or multisource instruments such as emissions trading—allow us to specify allowable emissions based on the level of protection we desire, while allowing sources the flexibility to decide the most cost-effective way to achieve the goal.

The second major stumbling block—the absence of adequate monitoring technologies—interferes with our ability to make greater use of performance-based approaches for environmental protection. The same instruments that are associated with risk-based strategies are also inherently performance-based. Others, such as design standards, may be less so but can sometimes be expressed in terms of desired emissions levels rather than specific activities or technologies. Moving toward performance-based approaches has the potential to improve cost-effectiveness in meeting goals, to allow at least some and at times considerable flexibility to sources, and to reduce the demands on government. However, OTA found that limitations on monitoring capabilities often get in the way of relying on such an approach, unless of course assurance of meeting goals can be completely disregarded.

Ignorance about many of these tools—hence the speculative nature of many of the evaluations in this report—is the third stumbling block we have identified. The United States has the most experience implementing single-source, fixed-target tools such as harm-based standards, design standards, and product bans or limitations. For others—tradeable emissions, pollution charges, integrated permitting, and challenge regulation—there are far fewer experiences or evaluations of these experiences on which to base decisions about appropriate uses.

If Congress would like to improve its ability to make effective choices from the full range of instruments, improvements are needed in scientific understanding of risks from pollutants, in the capability for monitoring emissions, and in understanding the strengths and weaknesses of the less-used tools. This section discusses several actions that Congress may want to consider for removing these major stumbling blocks.

Moving to a More Risk-Based Approach

Over the last 25 years, Congress has followed two broad types of strategies for environmental regulation: 1) *risk-based strategies* and 2) *technology-based strategies.* In a risk-based strategy, the target that individual or groups of sources must meet is based on modeled or measured environmental quality. For example, stationary sources of air pollutants such as sulfur dioxide may not emit that pollutant in quantities that would violate air quality standards in the vicinity of the facility. Under a technology-based strategy, the targets that sources must meet are based on technological capability or potential to lower pollution, rather than a directly specified level of environmental quality. Under this type of strategy, the level of environmental protection is indirectly specified by the stringency of the abatement requirement. For example, sewage treatment plants are required to remove a percentage of the pollutants entering the facility.

Congress has sometimes preferred one, and at other times the other, but has most often attempted to solve environmental problems through a combination of these two approaches to environmental protection. At first, under the Clean Air Act of 1970, Congress preferred a risk-based approach (with the notable exception of technology-based regulations for new pollution sources). The difficulties of actually implementing risk-based parts of the Act seemed to push Congress toward the other approach by the time of the Clean Water Act of 1972. Both strategies have advantages and disadvantages and, although certain types of problems might be better suited to one approach, the choice of approach depends to a great extent on the values of the decisionmaker.

Both types of strategies, of course, have environmental protection as their goal. The two differ most sharply in the means to achieve their goals and in the way the goals are translated into specific targets. To implement risk-based strategies, regulators need a fairly well-developed understanding of the science of pollutant transport, fate, and effect. Under technology-based strategies, regulators must have good knowledge of pollution prevention and control.

Those who favor a risk-based approach may regard technology-based strategies as the equivalent of "ready, fire, aim." Those who favor technology-based approaches often consider the other as the equivalent of "ready, aim, aim, aim. . ." There are elements of truth to both views.

Typically, the uncertainty surrounding the risks posed by pollutants is far greater than the uncertainty surrounding the potential for abatement. A high degree of uncertainty can lead to EPA's inability to implement congressional goals; at best, it will certainly slow the agency down (96). EPA's slow pace in issuing standards for hazardous air pollutants under the 1970 Clean Air Act is a prime example. Before the 1990 Amendments, when the Act was significantly changed, EPA had listed eight substances as hazardous air pollutants and promulgated emission standards for seven of these. Section 112 followed a harm-based strategy, requiring EPA to establish emission standards at a level that provides "an ample margin of safety to protect the public health." In the 1990 Amendments, Congress added a technology-based strate-

TABLE 1-7: Instruments Used for Risk-based Strategies and Technology-based Strategies

	Instrument: Risk-based strategy (based on acceptable risk)	Instrument: Technology-based strategy (based on technical potential)
Tools with fixed targets-single-source:		
Product bans and limitations	■	□
Technology specifications	□	■
Design standards	□	■
Harm-based standards	■	□
Tools *with* fixed targets-multisource:		
Integrated permitting	□	■
Tradeable emissions	■	■
Challenge regulations	□	■
Tools without fixed targets:		
Pollution charges	□	■
Liability	■	□

■ment often follows strategy
❑ Instrument occasionally follows-strategy
❑ Instrument rarely follows strategy

SOURCE Off Ice of Technology Assessment, 1995,

gy to the harm-based approach of this section, requiring EPA to issue emission standards for 189 pollutants. These emission standards, to be set by EPA, are to achieve the maximum degree of emissions reduction deemed possible by EPA.

As shown in table 1-7, some of the policy instruments covered in this study follow a risk-based approach, some are primarily technology-based, while others can be based on either approach. For those instruments with fixed targets that apply to single sources or products—the most common tools in use today—the choice of strategy guides one to particular instruments. If the analytical capability to support a risk-based approach exists, either harm-based emission standards or product bans and limitations are possible. A technology-based strategy can be implemented through either design standards or technology specifications.

Table 1-7 also includes multisource instruments and two of the instruments that do not have fixed targets. Note that most of these instruments can be used following either a risk-based or technology-based approach. For example, for both integrated permitting and tradeable emissions, all that is required is a fixed emissions target. The target can be set based on the level of risk posed by the emissions or simply on the technical potential for, and often the cost of, control. In the case of emissions trading to control acid rain, the congressional specification of allowable nationwide emissions seems to be based on a combination of the two strategies.

Pollution charges high enough to alter behavior have most often been discussed by economists in the context of a harm-based approach, that is, set at a level appropriate to damages that result from remaining emissions, but the charge can easily be technology based as well. For example, Sweden has set emission fees on nitrogen oxide emissions from electric utilities based on the expected cost of a particular technology (selective catalytic reduction) considered to be the best available technology at the time the fee was set.

For many problems, regardless of whether Congress prefers a risk-based strategy or a technology-based strategy, if ignorance of the risks posed by pollutants is too great, the option to use risk-based approaches is pragmatically foreclosed. Increasing research offers no guarantee of providing answers with the degree of rigor that Congress might desire. But reducing ignorance about the health and ecological risks posed by pollutants may at least create the opportunity to pursue harm-based regulatory strategies.

Thus Congress might consider several actions for improving the ability to use harm-based strategies. First, Congress could increase funding for research on risk assessment methods development. The estimated $75 million per year spent on methods development ($65 million for health risks (198) and $10 million for ecological risks

(50)) clearly has not provided a firm foundation for EPA decisionmaking. For example, a user fee of one cent per pound on the pollutants reported released or disposed of to the environment by facilities required to report emissions under the TRI, could be used to support research to help understand the environmental implications of the emissions reported. This would increase by 50 percent the funds available for risk-related methods research.

Second, when either establishing or amending an environmental protection program that follows a risk-based strategy, Congress could provide funds to be used specifically for the research needs to support that program. New risk-based regulations are likely to require considerable investments in research to improve capabilities for exposure assessment, for effects assessment, or both, in order for new initiatives to succeed.

Finally, Congress could direct EPA to use its existing authority under the Toxic Substances Control Act (TSCA) to require the sources of pollution to finance the chemical-specific data needed for use in risk assessments. EPA is currently planning to use this authority to request new information from sources of hazardous air pollutants (HAPs). EPA may soon issue a *Federal Register* proposal announcing its intent to require test data for about 20 of the 189 HAPs listed in the CAA, saving the agency an estimated $30 million to $40 million in testing costs (190).

Becoming More Results Oriented

Regardless of which policy instrument or combination of instruments is chosen, when Congress, EPA, or state regulatory agencies specify end results rather than the means for achieving the results, sources will have greater flexibility to achieve the targets in ways that are most cost effective or otherwise beneficial to them. Several of the policy instruments are inherently results oriented or performance based. Harm-based standards and tradeable emissions, which are expressed in terms of allowable emissions, are examples.

Other instruments can be expressed as either end results or as the means of achieving those results. Design standards are probably the best example of these. Under the Clean Water Act, Congress requires EPA to issue design standards as effluent limits or concentrations, that is, has mandated that they be performance based. This is not always the case, however, and some design standards end up looking more like technology specifications to sources. Sometimes this happens at the federal level; more often, it occurs as the permit is issued, typically at the state level.

The absence of accurate, reasonably simple, and affordable monitoring technology is one of the primary reasons that performance-based regulations are sometimes rejected. Moreover, this is often a reason that multisource instruments are avoided in favor of single-source approaches. From the opposite perspective, improved monitoring capabilities have been used to promote flexibility and increase assurance.

The more advanced the monitoring technology—relatively inexpensive, automated, reliable, and capable of frequent sampling—the easier it is to use policy tools that depend heavily on end results. When monitoring capabilities are poor, regulators are often hesitant to move from source-by-source instruments such as design standards to multisource approaches such as tradeable emissions and integrated permitting. Design standards at least offer some options for using surrogate measures for assuring compliance without the necessity of directly monitoring pollutants. For example, concern over the adequacy of methods to quantify volatile organic compound (VOC) emissions has been a stumbling block to establishing marketable emission programs for controlling urban ozone.

When monitoring technology is well developed, the likelihood of public and regulatory acceptance of alternative approaches, such as trading or fees, increases. An innovative program in Minnesota allows a tape manufacturer, 3M, more regulatory flexibility in exchange for substantial overall reductions in VOC emissions and the development of a continuous emissions monitoring system for VOCs.

To encourage the development and use of better monitoring technology, Congress could take several actions. First, it could increase funding to EPA for research on new emissions monitoring technologies. Research and development funding by EPA for new emissions monitoring methods is currently quite modest. Funding has averaged about $90 million per year over the last three fiscal years (217). About half of the research is for methods applicable for multiple media; of the single-media research, most is for air pollution monitoring.

Alternatively, Congress could encourage the use of preferred technologies by establishing economic incentives based on the characteristics of the methods chosen. For example, Congress could instruct EPA to develop discount factors similar to an approach adopted by Massachusetts, which rewards facilities for the use of better emission quantification techniques but still allows current methods. Massachusetts has designed an air pollution emissions trading program that uses a multiplier to adjust the emission reduction credits available for trading. Massachusetts leaves the type of monitoring up to each source but discounts emission reductions quantified through less accurate methods. Sources receive full credit for reductions that come from irreversible process changes, between 80 and 95 percent credit for reductions monitored using continuous emissions monitors, and so on to as low as 50 percent for reductions that are estimated rather than monitored. Thus there is a considerable economic incentive to use the more accurate methods.

Learning More About the Strengths and Weaknesses of Less-Often Used Tools

Even when decisionmakers decide on the criteria they wish to emphasize, knowing which instruments will be most effective is often difficult. Lack of experience using many of the tools and, consequently, the poor base of information about their performance are major stumbling blocks.

As discussed earlier, we have the most extensive experience with implementing single-source, fixed-target tools such as harm-based standards, design standards, and product bans or limitations. Information reporting, subsidies, and technical assistance are being used more frequently now in environmental protection programs than in the past, and we have some experience using these tools in related policy areas, such as agriculture and energy. For others—tradeable emissions, pollution charges, integrated permitting, and challenge regulation—we have even fewer experiences or evaluations of experiences on which to base decisions about appropriate uses.

In the United States, for example, use of pollution charges has been limited almost exclusively to volume-based fees for residential solid waste disposal. Other OECD countries have used pollution charges more widely to reduce emissions and, somewhat less often, for landfilled and incinerated wastes. However, these countries have only recently begun to experiment with setting the charges at a level high enough to ratchet emissions downward. In addition, OECD was able to find little systematic evaluation of these programs. Thus, as in the United States, little evidence exists for drawing conclusions about the problems for which pollution charges might be most effectively used and the type of institutional problems to be expected during implementation.

Yet interest in learning more about how these instruments actually work in practice, rather than in theory, is clearly growing. State and local governments, as well as EPA, have been incorporating less familiar policy tools to construct innovative approaches to meeting environmental goals. Industry trade associations, individual companies, and some environmental groups have joined in these efforts to find new approaches that are effective in achieving many of the criteria while making progress toward goals. To date, however, many more of these new approaches have been proposed than implemented, and many more implemented than evaluated.

Most evaluations of these instruments are done analytically or ex ante—that is, before the instruments are selected and implemented—to try to anticipate or predict likely outcomes. Post facto evaluations, based on sound methodological approaches, are almost never completed. Even when an evaluation is completed for a new approach, drawing clear lessons from the experiences of one or two facilities that could then be transferred with confidence to other facilities, companies, industries, regions, or problems is difficult.

If Congress wants information about instruments that have seldom been used in environmental programs, better information about instruments that are used widely, or better diffusion of the little information already available, two approaches might be considered.

First, Congress could encourage experimentation with some of the less well-known tools to learn more about their effectiveness in specific situations before advocating their widespread use. For example, Congress could establish a limited number of state or regional experiments using instruments or combinations of instruments with which the United States has little experience (e.g., challenge regulation, integrated permitting, and pollution charges). These experiments might involve many facilities (e.g., associated by an industry or a watershed) to increase the likelihood of identifying lessons about opportunities and problems across multiple facilities. This limited experimentation could improve the confidence policymakers have in using tools selectively to respond to state and local differences or particular problem characteristics.

Note that EPA is beginning to experiment with alternative regulatory strategies as part of the larger Clinton Administration effort to "reinvent government" (32). In Project XL, EPA is trying to determine how to allow firms that are environmentally "good actors" to replace existing regulatory requirements with more flexible alternatives—assuming they achieve better results than expected under existing law. In the Common Sense Initiative, EPA is experimenting with sector-wide industry agreements as a "complement to, or as a replacement for" traditional single-source regulations. These and other regulatory experiments are still in their early stages and Congress may wish to follow them closely.

Congress may also want to consider actions to establish or strengthen evaluations of implementation experiences with both unfamiliar and commonly used policy tools and to disseminate the results. To ensure that these evaluations build our knowledge base about the effectiveness of tools, they could be required to track the implementation and results of both experimental and existing programs. This knowledge could then be shared with the public and others in government and industry to improve the choices that are made in the future. Good ideas don't speak for themselves. Thus, Congress might want to consider asking EPA to strengthen its role in facilitating the transfer of information about how these instruments actually work in various settings.

Pollution Control Today 2

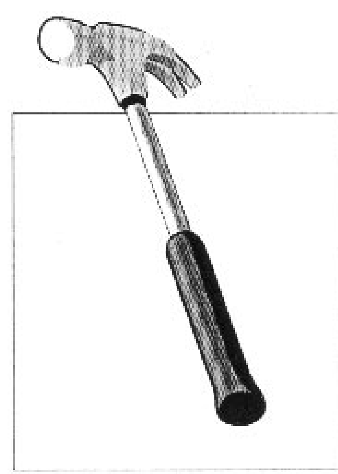
In the 25 years since the issue of environmental protection first exploded onto the American political agenda, Congress has enacted and revised dozens of relevant statutes. Most of these laws are regulatory in nature; they are designed to change private conduct in ways that will help preserve and protect the human environment. In this chapter, we characterize which pollution problems are regulated today or are likely to be in the near future.

In the first section, we look at pollution control from two perspectives. First we outline where our pollution control dollars are being spent today and briefly review the progress cleaning up the environment over the last two decades. After that, we present one view of the pollution problems that still remain.

In the second section, we present four case studies that illustrate the issues raised when "real world" environmental programs are designed and implemented. Specific instruments are chosen to achieve environmental goals, but they obviously must satisfy other criteria as well. Each program offers a glimpse of the various ways each of the seven criteria (briefly presented in chapter 1 and discussed more fully in chapter 4) have been or could have been taken into account to choose effective policy tools.

The case studies illustrate the use of instruments that directly limit pollution and those that lower pollution but do not set fixed targets. In the first group we describe the use of tradeable emissions in an air pollution control program in the Los Angeles area and the use of integrated permitting in New Jersey. These two policy tools are among the less used, but quite promising, approaches in the environmental policy toolbox.

Many of the instruments considered in this study do not have fixed pollution targets. The third case study illustrates one of



these, information reporting, by discussing two California programs: Proposition 65 and the Air Toxics "Hot Spots" program. Our fourth case study focuses on technical assistance, as used under the Massachusetts Toxics Use Reduction Act.

TODAY'S PROBLEMS

Before we move on to consider the values and interests policymakers bring to problem solving, we need to take a quick look at the kinds of problems we are working on today and may face tomorrow. After all, our choice of policy tools is likely to be in large part influenced by the characteristics of the problem being addressed.

Today the United States is spending about $100 billion per year controlling and preventing pollution. While controlling pollution more wisely may lower these costs, the demands from a growing economy can be expected to offset some of, or even overshadow, these gains. Understanding which problems require the largest expenditures and who pays the bills can help identify those targets that may yield the largest cost savings. There are certainly many inefficiencies in the way the nation protects the environment. It makes sense to look first at those areas that cost the most.

But knowing the problems most of the money is spent on today illuminates only part of the picture. Even with today's substantial investment of money and effort, many environmental problems remain and new ones may emerge. Later in this section we review the results of an EPA exercise to rank remaining environmental priorities in each of the 10 EPA regions. The wide variety of types of remaining problems and sources identified in this exercise underscores the need for a diverse set of policy tools.

The Cost of Pollution Abatement

About 85 percent of the approximately $100 billion spent annually on pollution abatement is tied to the requirements of the Clean Air Act (CAA), the Clean Water Act (CWA), and the Resource Conservation and Recovery Act (RCRA)—the three statutes covered in this report—or similar state and local programs. Figure 2-1 displays current environmental expenditures under these and other environmental statutes. About one-third of the total is spent controlling water pollution; somewhat over 20 percent controlling air pollution; another 20 percent disposing solid waste; 15 percent preventing, treating, and storing hazardous waste; 5 percent cleaning up old hazardous waste sites; and about 1 to 3 percent each on drinking water, pesticides, and other toxic chemical programs.

As can be seen in figure 2-2, about 45 percent of the total is spent by government (with local government spending the largest share), 40 percent by business, and 15 percent directly by households.

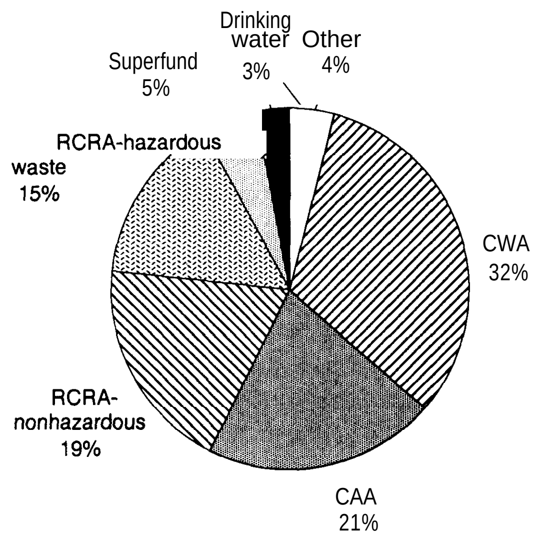
Again, about one-third of today's abatement costs are spent to maintain and improve the quality of the nation's surface water. The vast majority of this expenditure is to clean up wastewater from identifiable municipal and industrial sources. While many of these sources have significantly reduced their discharges over the last 25 years, many lakes, streams, and estuaries are still impaired. Another source of water pollution—nonpoint source pollution from agricultural and urban runoff—is ranked among the very top of remaining risks to ecosystems. Relatively little is spent on controlling nonpoint source pollution today; moreover, the costs of controlling many of these sources in the future might also be quite high.

Of the total water pollution control costs, close to 65 percent is spent by federal, state, and, primarily, local governments. Business spends about 30 percent and the remainder is spent directly by households.

Information on water quality trends—that is, the progress made over the last two decades—is almost completely lacking. Much anecdotal information and data collected by the U.S. Geological Survey (USGS) on a limited number of sites nationwide indicate some improvement for some contaminants (e.g., bacteria and phosphorus). However, for other contaminants (e.g., dissolved oxygen and nitrates), the USGS data show no discernible trend (91).

Although data are sketchy even about *today's* water quality, currently about 40 percent of the nation's river miles that have been assessed either do

FIGURE 2-1: Pollution Abatement Expenditures, by Statute, 1991



SOURCE: Office of Technology Assessment, modified from Don Garner, "Pollution Abatement Costs," Contractor Report to OTA, 1994.

not support, or only partially support, the beneficial use designated by the state (e.g., swimming, fishing, drinking, or support of aquatic life). About 45 percent of assessed lake area and 35 percent of estuaries do not support, or only partially support, designated use (212). Agriculture is thought to be the single largest source of remaining river and lake water quality problems. Sewage treatment plants and urban runoff are the largest contributors to remaining estuarine water quality problems.

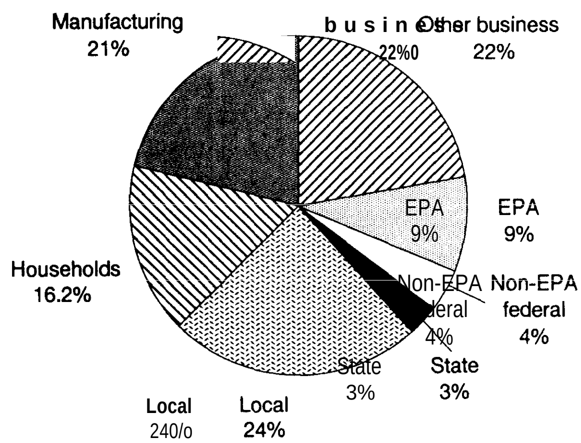
Somewhat over 20 percent of today's abatement expenditures are for air pollution control. These expenditures have contributed to a 25 percent drop in emissions of carbon monoxide, sulfur dioxide, and volatile organic compounds since 1970. Particulate matter has dropped about 50 percent and lead emissions have dropped by 98 percent since 1970. Nitrogen oxide is the only criteria air pollutant to have increased since 1970, by about 10 percent (205).

However, much remains to be done. Many areas still do not meet air quality standards for criteria air pollutants such as urban ozone. About 60 million people live in counties with air quality levels that do not meet the national standards for one or more pollutants. About 50 million people live in counties that exceed air quality standards for urban ozone. About 12 million people live in counties that exceed air quality standards for carbon monoxide, and about nine million people live in counties that exceed standards for particulate matter (21 1). The recently amended program to control emissions of hazardous air pollutants is still in its early stages.

In contrast to water pollution control, most air pollution control costs are borne by the private sector. About 55 percent is spent by business and 35 percent by households (primarily for auto pollution control devices).

Just under 20 percent of total costs are spent on solid waste. As we shall see in the next section, municipal solid waste is often judged to be among the lower risks to both human health and natural

FIGURE 2-2: Pollution Abatement Expenditures, by Sector, 1991



SOURCE: Office of Technology Assessment, modified from Don Garner, "Pollution Abatement Costs," Contractor Report to OTA, 1994 ecosystems. However, siting landfills is becoming increasingly difficult, which results in higher disposal costs. Per capita net discards of solid waste have been declining over the past decade due in part to increased rates of recycling, but not fast enough to offset population growth (48). Solid waste disposal costs are shared about equally between government and the private sector.

Another 20 percent of the total is spent on hazardous waste. About three-quarters is spent dealing with hazardous waste under RCRA and the remainder to clean up existing hazardous waste sites under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA, also called Superfund). Most of the costs of dealing with hazardous waste are borne by business.

The remaining 10 percent of the total is spent on regulations under the Safe Drinking Water Act, regulating pesticides under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA), regulating new chemicals under the Toxic Substances Control Act (TSCA), and a few other statutes implemented by EPA. Most of the drinking water costs are spent by government and the bulk of the costs under the other statutes is spent by the private sector. As we shall see in the next section, the risks from drinking water and pesticides rank quite high on comparative assessments of risk.

Figure 2-3 breaks down pollution abatement expenditures by both statute and sector. Again, of the $100 billion per year spent on capital and operating costs, government and businesses each spend between 40 and 45 percent of the total. Households pay the remainder, about 15 percent.

Among businesses, expenditures are about equally divided between manufacturing and other businesses, for example, electric utilities and mining. Of the government expenditures, local government by far spends the most, about one-quarter of the nation's total.

The bulk of the expenditures by business is for air pollution control, water pollution control, and dealing with hazardous wastes under RCRA and CERCLA. Businesses spend between 10 and 12 percent of the total abatement expenditures from all sectors in each of these three areas. Households spend about 7 percent of the total for cleaner cars and gasoline and an additional 5 percent for solid waste disposal.

The largest government expenditures are for water pollution control. About 16 percent of total pollution control costs are spent by state and local government on publicly owned treatment works (POTWs) and other sewerage. The federal government spends an additional 4 percent through the State Revolving Fund. Government costs for solid waste disposal are also significant. About 9 percent of total pollution abatement costs is spent by local governments dealing with trash. In addition to funds appropriated to states and local governments to help build POTWs, the federal government spends a significant amount on hazardous waste. Some of this, over 3 percent of nationwide costs, is spent on Superfund. A similar and rapidly increasing amount is spent dealing with hazardous waste at government facilities.

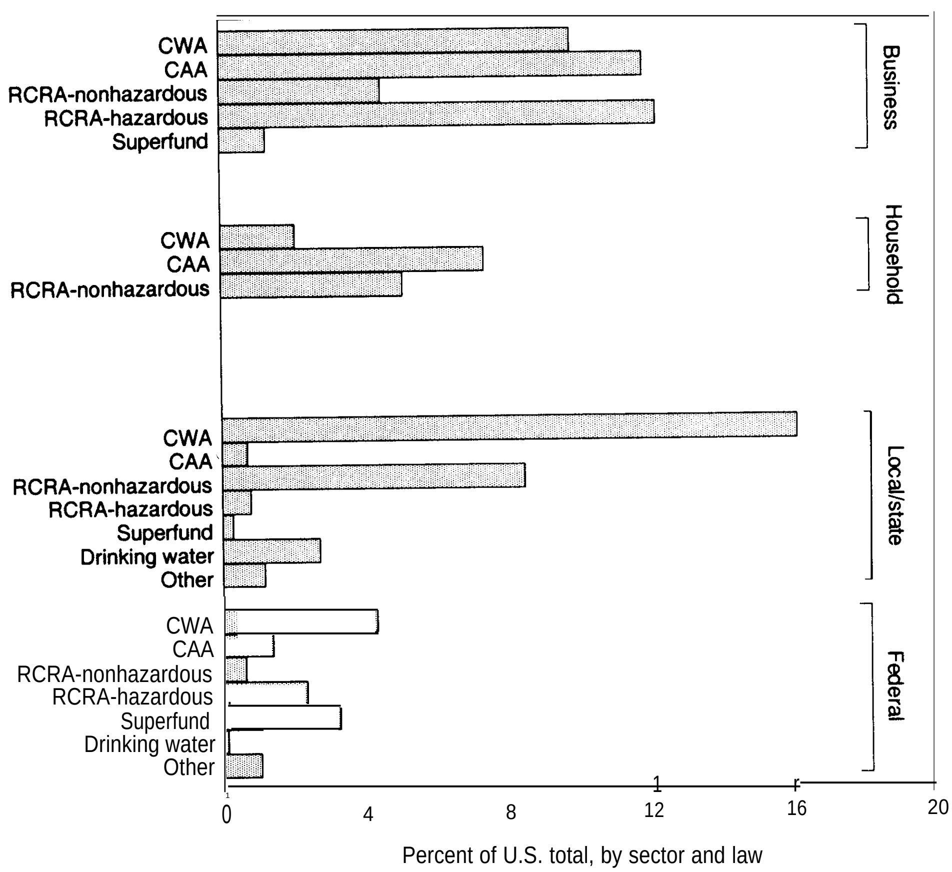
Pollution abatement expenditures are a small but noticeable percentage of expenditures within each of these sectors. Total expenditures are equal to about 2 percent of the gross national product.

Government expenditures, on a percentage basis, are somewhat higher than private sector expenditures. Close to 4 percent of local government expenditures are devoted to environmental protection, again with most of this going to sewage treatment and solid waste disposal. Close to 1.5 percent of federal expenditures (not counting Social Security or Medicare) are for pollution abatement.

Less than 0.5 percent of household expenditures go to pollution abatement. By businesses, this percentage is just under 1 percent of the value of shipments. However, as shown in figure 2-4, this percentage varies considerably. Figure 2-4 displays pollution abatement costs as a percentage of value of shipments for manufacturing and several major nonmanufacturing industries. These costs are disaggregated to the finest resolution available—the four-digit standard industrial code (SIC).

Control costs are as high as 9 percent of value of shipments, but for very few industries. For the 11 four-digit SIC industries where control costs ex-

FIGURE 2-3: Pollution Abatement Expenditures, by Statute and Sector, 1991



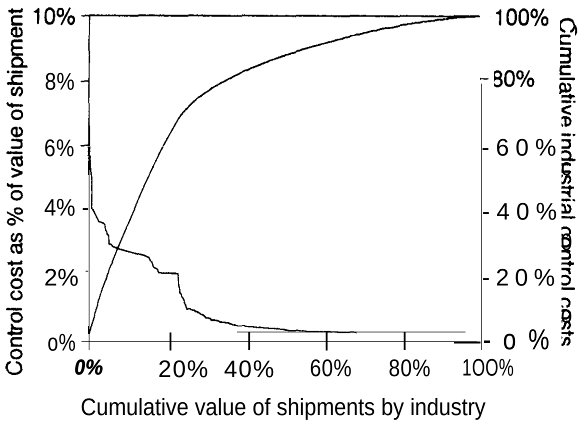
SOURCE: Office of Technology Assessment, modified from Don Garner, "Pollution Abatement Costs," Contractor Report to OTA, 1994.

ceed 4 percent of value of shipments, their total value of shipments is about 1 percent of the industrial total. Those industries whose control costs exceed 2 percent of value of shipments spend close to two-thirds of industrial control costs but are responsible for about 20 percent of the value of shipments. Those industries where control costs are less than 1 percent of value of shipments are responsible for about 75 percent of the total value of shipments.

If media attention were the only guide, one might assume that the bulk of the nation's pollution abatement expenditures was devoted to dealing with hazardous materials, with very little of it spent on pollution prevention. This is not the case. Using the above estimates as a rough guide, about one-third of abatement costs are spent on hazardous pollutants. The rest is for controlling criteria air pollutants such as ozone and particulate, conventional water pollutants such as suspended solids and oxygen-demanding materials, and solid waste.

Pollution prevention is more prevalent than is usually recognized. The only reliable data on pollution prevention versus end-of-line control methods are for capital expenditures within manufacturing. The last decade has seen a marked increase in the use of pollution prevention. During

FIGURE 2-4: Pollution Abatement Costs versus Value of Shipments by Industry, 1991



SOURCE: Office of Technology Assessment, modified from Don Garner, "Pollution Abatement Costs," Contractor Report to OTA, 1994

the early 1980s, manufacturers reported about 15 percent of their abatement expenditures for pollution prevention. Over the last 10 years, this has doubled. A U.S. Census Bureau survey estimates that about 35 percent of capital expenditures in 1992 were for pollution prevention. This varies somewhat by medium, ranging from about 25 percent for water pollution control, to 35 percent for waste, to about 43 percent for air pollution control.

▮ Remaining Environmental Problems

Tomorrow's environmental agenda will contain many new priorities, but much of it will be filled with problems that remain from yesterday. This is the conclusion of several reports that have attempted to assign qualitative rankings for today's major environmental risks as part of an effort for setting tomorrow's environmental priorities. These include two national studies and comparative risk exercises by all 10 EPA regions and by six states.

As might be expected, there are both similarities and significant differences among the results. Some of these differences are due to the fact that environmental problems vary from region to region. Other differences stem from the regrettably crude state of the art of comparative risk assessment. While such attempts do help identify significant environmental problems, they also make clear that: 1) much of the information needed to compare risks is not available; and 2) priority setting depends as much on values as estimates of harm.

Some of the problems identified have been addressed by the major environmental laws for two decades but have been resistant to solution. Others have received little attention to date. They are found in all media—air, water, and land-and they include both risks to human health and risks to natural ecosystems.

The first of these reports, *Unfinished Business,* was prepared by EPA in 1987. EPA first identified 31 environmental problem areas and then qualitatively identified and ranked the remaining risks to human health, ecological, and social welfare.

The key risks to human health identified by the report included the following:

- indoor air pollutants, including radon;
- worker exposure to chemicals;
- pesticides;
- criteria air pollutants, such as fine particulate and urban ozone;
- consumer product exposure;
- hazardous air pollutants;
- drinking water; and
- accidental releases of toxics.

Note that the health risks within this highest category are *not* ranked, due to both data limitations and the difficulty of comparing cancer and noncancer health risks.

Unfinished Business judged the following ecological risks as greatest:

- global warming;
- stratospheric ozone depletion;
- physical alteration of aquatic and terrestrial habitats; and
- mining and gas and oil extraction.

The report ranked several ecological risks somewhat lower, but still high:

- criteria air pollutants;
- point source discharges of water pollutants;

- nonpoint sources of water pollutants; and
- pesticides.

Several years later, EPA's Science Advisory Board (SAB), in response to a request by the EPA Administrator to review *Unfinished Business*, issued its own list of the most significant environmental risks. The SAB Human Health Committee felt that four of the high-risk human health problems identified by *Unfinished Business* were firmly supported by available data:

- ambient air pollutants, including both criteria air pollutants and hazardous air pollutants;
- indoor air pollution;
- worker exposure to chemicals in both industry and agriculture; and
- pollutants in drinking water.

The committee stated that many of the other areas identified by *Unfinished Business* involved "potentially significant exposure of large populations," but that the "data bases to support these concerns are not as robust" as for the four problems listed above.

The Ecology and Welfare Committee identified four high risks:

- global warming;
- stratospheric ozone depletion;
- habitat alteration and destruction; and
- species extinction and overall loss of biological diversity.

Two of the ecological risks ranked relatively high by *Unfinished Business* were ranked as medium-risk problems by the SAB committee:

- water pollution, such as toxics, nutrients, biochemical oxygen demand, and turbidity; and
- pesticides.

Recognizing that such nationwide rankings could not adequately reflect the regional variation among environmental problems, EPA asked each of the 10 EPA regions to undertake comparative risk-ranking exercises and sponsored similar exercises by the states. Results of the regional exercises, displayed as figures 2-5 and 2-6, illustrate regional variation and, once again, differences of opinion among different groups doing the evaluations.

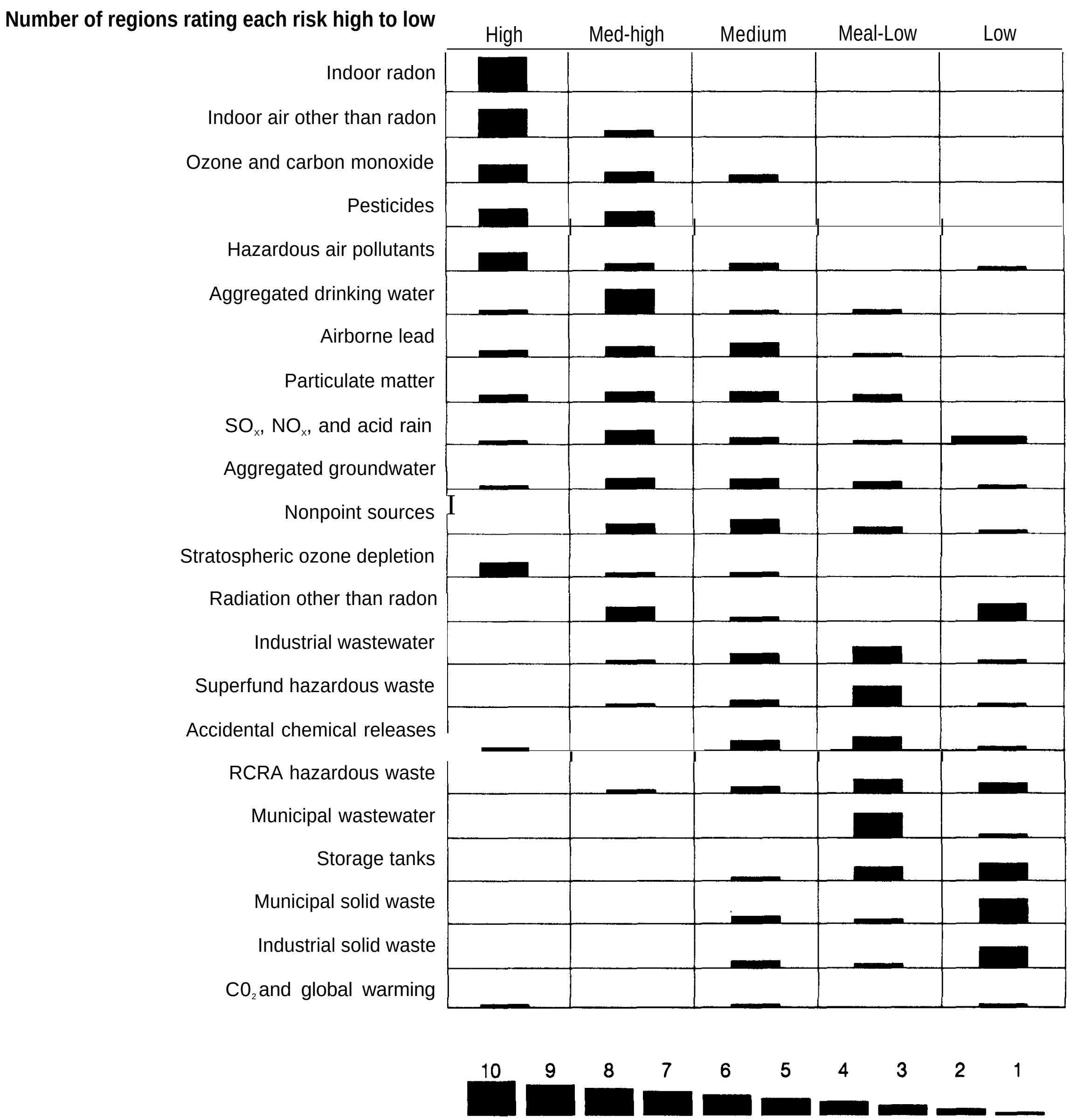
Figure 2-5 displays the number of EPA regions rating each of approximately 20 problem areas as high, medium-high, medium, etc., with regard to risks to human health. The categories are similar but not identical to those used in *Unfinished Business* and the SAB report. For example, the category of "criteria air pollutants" is further disaggregated to ozone and carbon monoxide, particulate matter, airborne lead, and sulfur and nitrogen oxides. Several of the earlier categories are missing (including worker exposure to chemicals, rated as one of the highest risks, but not within EPA's jurisdiction). The order in the figure displays a rough nationwide ranking,[1] by ordering those risks rated highest by the most EPA regions first. Note, however, the widely scattered results: three-quarters of the risks were rated as high or medium-high by at least one EPA region.

The rough nationwide ordering that results from combining each of the 10 independent regional comparative risk exercises tracks fairly closely to the nationwide studies discussed above. The highest ranked human health risks include some risks that we have been grappling with for many years (e.g., ozone and carbon monoxide, pesticides, and drinking water), risks that only recently have been recognized as major and not well addressed by our current system (e.g., indoor air pollution, including radon), and at least one (hazardous air pollutants) that has recently been addressed by a significantly expanded regulatory program.

Figure 2-6 displays the rankings of ecological risks by the 10 EPA regions. Physical alteration of natural habitats are ranked high by all of the risk-ranking exercises—all 10 EPA regions and the two nationwide exercises. The nationwide exer-

[1] Risks were ordered from highest to lowest by assigning 5 points for each region that rated a risk as high, 4 points for a medium-high rating, 3 points for a medium rating, etc. Other weighting schemes would, of course, result in somewhat different rankings.

FIGURE 2-5: Ranking of Human Health Risks, Ratings by 10 EPA Regions

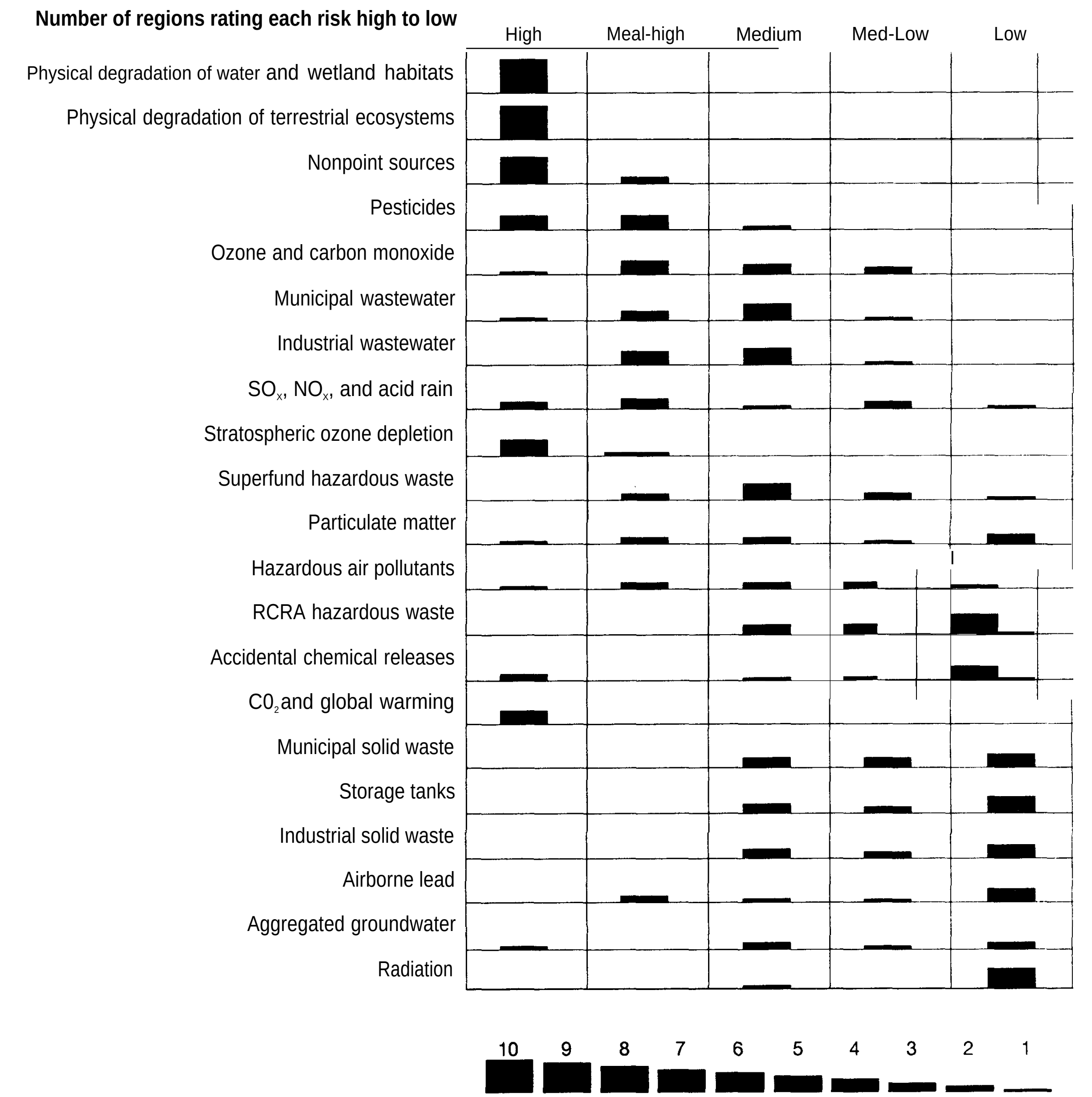


SOURCE: Data on regional rankings provided by R. Curry, Strategic Planning and Management Division, U.S. Environmental Protection Agency.

cise ranked two global issues—global warming and stratospheric ozone depletion—higher than the regional efforts. The regional efforts ranked more localized problems, such as nonpoint source water pollution, pesticides, and ozone, higher than the nationwide exercises. This may have been due to a difference of opinion or values, or merely that the regions felt that their job was to identify risks for *regional* attention.

Some of the problems mentioned above pose risks to both human health and ecosystems, for example, pesticides, stratospheric ozone depletion,

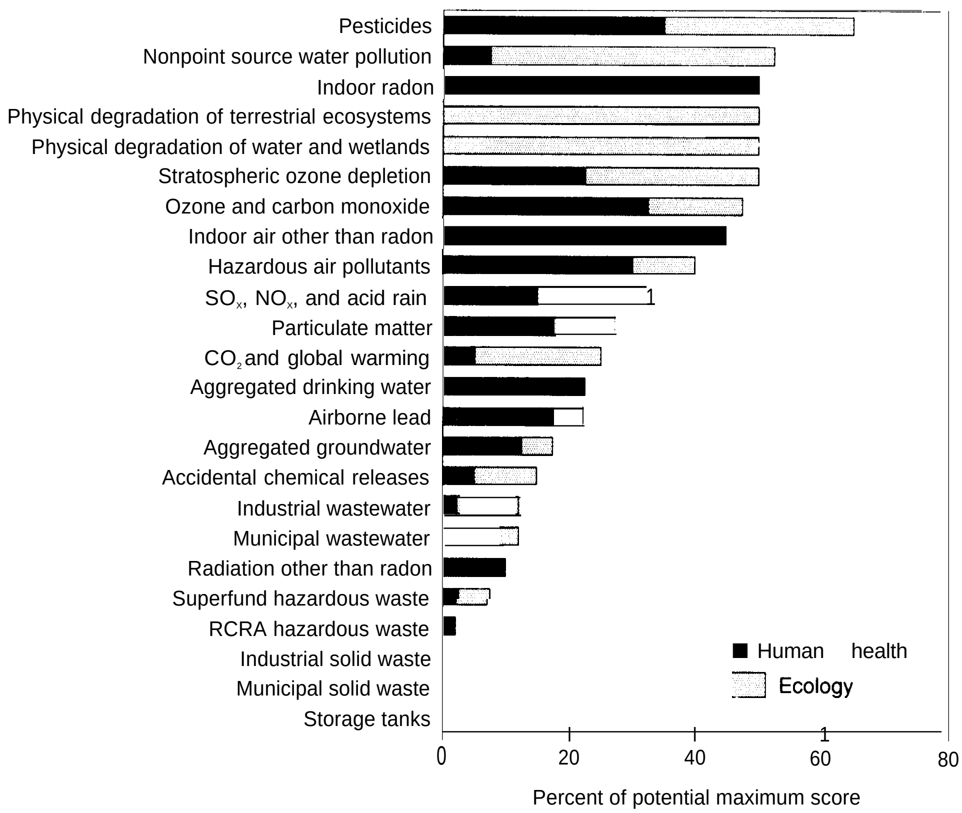
FIGURE 2-6: Ranking of Ecological Risks, Ratings by 10 EPA Regions



SOURCE: Data on regional rankings provided by R. Curry, Strategic Planning and Management Division, U.S. Environmental Protection Agency

and criteria air pollutants such as ground level ozone and sulfur and nitrogen oxides. Others pose risks primarily to one or the other, for example, physical alteration of natural habitats, nonpoint source water pollution, and indoor air pollution, including radon. Figure 2-7 displays a rough "combined risk ranking" of the combined concerns of the 10 EPA regions. The ranking assumes that equal concern is given to human health risks and ecological risks. Weighting one more than the other would, of course, result in different rankings.

FIGURE 2-7: Combined Human Health and Ecological Risk, Rankings by 10 EPA Regions



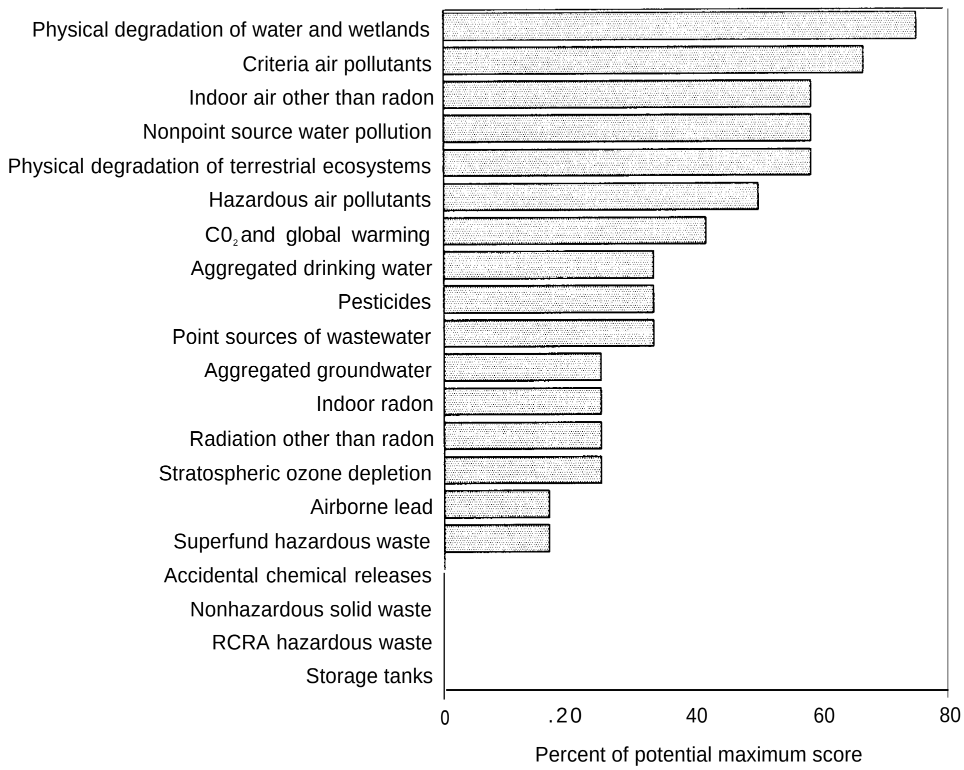
SOURCE: Office of Technology Assessment, based on data on regional rankings provided by R. Curry, Strategic Planning and Management Division, U.S. Environmental Protection Agency,

EPA has sponsored risk-ranking exercises by states as well. Figure 2-8 displays the results of these exercises by six states: California, Colorado, Louisiana, Michigan, Vermont, and Washington. All but California provided integrated risk rankings, that is, evaluated each of the problems by considering all of the risks—both to human health and to ecosystems—that they pose. Note the somewhat similar ranking of the most serious problems by the EPA regions and the states, with a few notable exceptions: indoor air pollution, pesticides, and stratospheric ozone depletion are considerably further down the states' lists. Complicating the comparison, however, is that not all the states followed the same procedure. Some of the states (e.g., Washington and Louisiana) ranked priorities for state action while others (e.g., Vermont and Colorado) ranked risks to the state, regardless of whether they felt state action was appropriate.

MATCHING TOOLS TO PROBLEMS

The case studies examined in this chapter illustrate the issues raised when real-world environmental programs are designed and implemented. Specific instruments are chosen to achieve environmental goals. These choices offer at least some glimpses of the various ways each of the seven criteria briefly presented in chapter 1 and discussed

FIGURE 2-8: Combined Human Health and Ecological Risk, Rankings by Six States



SOURCE: Office of Technology Assessment, based on data on state rankings provided by D. Martin, Strategic Planning and Management Division, U.S. Environmental Protection Agency.

more fully in chapter 4 have been taken into account.

The first two case studies illustrate several of the less commonly used—but especially promising—instruments with fixed emissions targets: tradeable emissions and integrated permitting. The latter two case studies illustrate two of the available approaches without fixed targets: information programs and technical assistance. The specific examples and criteria discussed in each case study are shown in box 2-1.

■ RECLAIM Tradeable Emissions Program

The Regional Clean Air Incentives Market (RECLAIM) is one of the biggest experiments in environmental regulation in the United States. Many stakeholders took part in the lengthy negotiation necessary to formulate and adopt a controversial pollution control program. Emissions trading, long discussed in economic literature and adopted in the 1990 Amendments to the Clean Air Act (CAA) for controlling acid rain, is the focus and hope for more cost-effective air pollution emissions reduction in the South Coast Air Quality Management District (District).

RECLAIM, first implemented in January 1994, took three years to develop because of an unusually open and public process. Growing federal interest in alternative regulatory approaches and serious concern with the cost of air pollution control in California's troubled economy spurred

BOX 2-1: Case Studies: Tools, Criteria, and Key Issues

Tradeable Emissions

RECLAIM, Los Angeles area:

Cost-effectiveness and fairness: As reductions to meet air quality standards became increasingly expensive under the previous control plan, both industry and government began searching for ways to lower emissions more cost-effectively. The perception of what is a "fair" initial allocation of permits and a fair rate of reductions differed among stakeholders.

Assurance of meeting goals: State-of-the-art monitoring was a crucial component for ensuring that individual sources were accountable for reductions and that the program could be enforced. This ultimately limited the types of sources that could participate.

Environmental equity and justice: Public interest groups were concerned that trading might lead to higher ozone levels in predominantly Black and Hispanic areas, compared with levels under the source-specific program it replaced.

Integrated Permitting

New *Jersey:*

Pollution Prevention: The program requires formal facility-wide pollution prevention planning as a condition for integrated permitting.

Adaptability: The integrated permit incorporates a range of acceptable changes, allowing a facility to quickly make process changes in response to market opportunities without needing additional agency approvals.

Information programs

Proposition 65 and "Hot Spots" program, California:

Assurance of meeting goals: Although both programs establish incentives for lowering exposures to toxics, neither provides much assurance to the public that goals will be met. The "Hot Spots" program was amended several years later to require reductions.

Pollution prevention: Proposition 65 assumes that consumers will reject products using toxics, thus pressuring companies to prevent pollution by finding substitutes.

Environmental equity and justice: Giving communities or individuals information about risks or about emissions can improve their ability to identify potential dangers. Both programs report risk—as opposed to emissions asunder the federal Toxics Release Inventory—an easier measure for the public to interpret.

Technical Assistance

Toxics Use Reduction Act, Massachusetts:

Adaptability to change: A service unit oriented toward client needs can incorporate changes in these needs and modify its practices in response to information about new technologies or changed understanding of risk rather easily in comparison to other types of instruments.

Technology innovation and diffusion: A focus on small firms without R&D capability and efforts to link experts can facilitate diffusion and might improve chances for innovation. Institutional and geographic separation of a state's R&D group from its outreach group may diminish opportunities for learning and cross-fertilization of ideas.

SOURCE: Office of Technology Assessment, 1995,

the District to attempt a major experiment in regulation.[2]

District regulators were faced with many challenges before program development even began—for example, the need to fit into an already elaborate regulatory structure at the state and federal level. The RECLAIM program, which is part of the District's Air Quality Management Plan (AQMP), must be approved by the California Air Resources Board (CARB) to be incorporated as part of the State Implementation Plan (SIP) to demonstrate compliance with both the federal CAA and the California Clean Air Act (CCAA) (180).

In addition, the District accepted five criteria that were used to further guide RECLAIM development (179):

- enforcement of emission reductions must provide confidence equal to or greater than the existing air quality control program;
- emission reductions must be equal to or greater than the 1991 Air Quality Management Plan (AQMP) and future control plans;
- implementation costs must be less than the 1991 AQMP;
- job impacts must be less than the 1991 AQMP; and
- adverse public health impacts should not result from implementation of the program.

The development process began in 1990 and included numerous meetings, hearings, and workshops over a several-year period. Although RECLAIM has been in place for less than two years, the story of its selection and design as a regulatory approach is of particular interest as an example of regulatory decisionmaking and the tradeoffs that are made in the process.

How RECLAIM Works

At the most basic level, RECLAIM establishes an emissions trading market for stationary sources in the District that emit four tons or more of nitrogen oxides (NO_x) or sulfur dioxide (SO_2) per year.[3] At the time of implementation, total RECLAIM sources included 41 SO_2 facilities (representing approximately 85 percent of the reported SO_2 emissions from stationary sources in the District) and 390 NO_x facilities (representing about 65 percent of permitted NO_x stationary source emissions in the District) (180). Each facility receives a facility permit, which includes a list of all emission sources, annual reduction targets, quarterly emission limits, and compliance requirements in accordance with requirements of the CCAA and the federal CAA. This permit establishes the facility-wide emission level for each year from 1994 to 2003 and the corresponding annual allocation of Regional Trading Credits (RTCs) as determined by the District (based on past peak production and requirements of existing rules and regulations). An RTC represents one pound of either NO_x or SO_2 emissions and is a tradable commodity meant to be bought or sold for use within the year of its creation. Facilities must hold enough RTCs to cover their actual emissions.

The program is designed to require facilities to reduce emissions in the District by 8.3 percent per year for NO_x and 6.8 percent per year for SO_2 from 1994 through 2003 (102). It is expected that the presence of the emissions trading market will help lower the costs of meeting air pollution goals in the District as outlined by the 1991 AQMP. RECLAIM is a more flexible—and thus it is hoped more cost-effective—regulatory approach because it allows firms to control their emissions un-

[2] For example, see recent EPA rule on economic incentive programs: U.S. Environmental Protection Agency, "Economic Incentive Program Rules," final rule and guidance, *Federal Register* 59(67), Apr. 7, 1994.

[3] Separate trading markets exist for NO_x and SO_2. A volatile organic compound (VOC) market is in development and scheduled for adoption by fall 1995.

der a facility-wide emissions cap rather than requiring individual permits and controls for each emissions source in a facility. In addition, the RTC has value as one pound of NO_x or SO_2 emissions, and firms best able to make emission reductions may sell the credits to firms less able to make reductions for technical or economic reasons. In effect, RECLAIM allows firms to better "manage" their emissions by allowing more choice in how reductions are made and by placing a value on emission credits that creates an incentive to make reductions in order to sell those credits.

RECLAIM and the OTA Criteria

The selection and development process for RECLAIM involved detailed analysis of most of the decision criteria discussed in the previous chapter. Through the iterative nature of the program's design, stakeholders explicitly addressed assurance of meeting environmental goals, costs, equity and fairness, and technology innovation, among many other concerns. While all of these issues would be worth exploring, this case study will focus primarily on three of the OTA criteria: 1) fair and cost-effective use of resources; 2) environmental justice; and 3) assurance of meeting environmental goals.

Cost-effectiveness and fairness to sources

Cost-effectiveness—Lowering the high cost of control was one of the primary motivating factors for choosing emissions trading as a regulatory approach in the District. The economics literature and the early feasibility studies conducted for RECLAIM development provided theoretical support that emissions trading could help lower the costs and impacts on society while achieving the necessary pollution reductions (128,178). The conditions seemed right for a trading program with the large number of identifiable stationary sources, all of whom faced inherent variations in control costs.[4] Emissions trading offered flexibility to the regulated entities while maintaining a firm target of pollution control.

Just how significant cost savings will be under the RECLAIM regulatory approach is difficult to determine. While extensive analysis was conducted on the costs to the regulated industry groups (181), disaggregating down to a firm level was not possible, primarily because of a lack of facility-specific information. Various assumptions were made—including information on air pollution control technology currently in place, past production levels, and projected growth—in order to begin to model likely sellers and buyers and other impacts of a trading market (103). In addition, very little analysis is available on the relevant government costs. With these limitations in mind, the District's analysis did show that the costs of emission reductions with RECLAIM would be on the order of one-quarter to one-third less than the approach previously outlined in the 1991 AQMP in the years 1996-1999 (181). These cost estimates for RECLAIM were obtained through use of two forecasting models and include compliance, opportunity, and increased monitoring costs associated with the program.

It is assumed that under this type of market system, firms will choose the least expensive means of pollution control. Since RECLAIM establishes a facility emissions cap, eliminating most source-specific pollution control measures, firms are able to utilize many different options to make emission reductions including process changes, installation of control equipment, purchases of emission credits, and changes in operating or other methods (181). The RECLAIM cost-savings projection assumes that facilities will better "manage" their emissions by shifting from relatively high-cost controls to relatively lower-cost sources, both making the needed reductions and potentially freeing up RTCs for sale on the market. In addition, firms that are not able to make cost-effective reductions can potentially purchase RTCs on the

[4] The earliest program proposal included markets in VOC and NO_x, which potentially would have included approximately 2,700 facilities. South Coast Air Quality Management District, "RECLAIM: Feasibility Study," Diamond Bar, CA, March 1992.

market at a lower cost. Whether firms actually do maximize profits will vary, though the connection between emission reductions and the bottom line should motivate firms to take advantage of savings wherever possible in the system.

Compliance costs for both RECLAIM and the approach outlined in the 1991 AQMP include capital, operating, and maintenance expenditures on control equipment. Although overall costs are estimated to be lower under RECLAIM, some industry groups are winners and some are losers. Those expected to gain the most include public utilities, petroleum, stone and clay, and the construction industries. Industries expected to pay more under RECLAIM include primary metals, paper, and mining (181). These cost savings for firms are expected to be bolstered by new technologies available with the expanded incentive for innovation due to the presence of the market. The positive finding for cost savings to industry also implies lower future job impacts due to regulation. RECLAIM analysis shows an expected 1,100 fewer jobs lost annually on average between 1994-1999 under RECLAIM than the earlier plan (181).

Determining cost-effectiveness for firms in an emissions market also requires consideration of costs associated with monitoring, recordkeeping, and transactions. District analysis estimates that total control costs for NO_x and SO_2 RECLAIM firms will be about $75 million per year in 1996 and $165 million by 1999. The District estimates that average cost of monitoring and recordkeeping (as part of control costs) will be about $13 million per year between 1994 and 1999. That estimate reflects approximately $10 million for use of Continuous Emission Monitoring Systems (CEMS), and about $2 million for Continuous Process Monitoring Systems (CPMS). The remaining $0.3 million is assigned to operating costs for Remote Terminal Units (RTUs) in some facilities (181).

Of course, whether these estimated cost savings come about depends on how closely the modeled assumptions match what actually happens. Looking more closely at what is forecast to happen in a typical year, 1997, is instructive. In this year, RECLAIM is expected to cost $94 million in comparison to $127 under the old AQMP, a savings of about $34 million or 25 percent. Some of this savings is assumed to come from more rapid innovation that might occur under a trading scheme. As discussed in chapter 4, this is plausible, but neither economic theory or empirical evidence leads one conclusively to this assumption. Omitting the assumed effects of innovation might lower the savings by $5 to $10 million. Some of this savings come from the lower NO_x emission reductions required in 1997 under RECLAIM than under the old AQMP. Thus about $7 million to $13 million of the lower cost comes from requiring lower emission reductions.

The District's estimate of savings assumes that all cost-effective trades that might occur will occur. The District's analysis indicates that about one-quarter of the NO_x reductions below 1994 levels in 1997 will be traded (i.e., about 9 of the 35 tons per day). To the extent that some of these trades do not occur, due to mistrust of the market or because the additional effort may just not seem to be worth the bother, some of the remaining forecasted savings also will not occur. However, the District's model is not able to account for cost savings that might occur *within* facilities. These are the types of "trades" that are most likely to occur in the early years at the largest sources. Thus it is unclear whether, on balance, the estimates of trading are high or low.

Most of the cost savings appear to come from "time shifting," that is, sources scheduling the cheapest emission reductions first, rather than according to the somewhat arbitrary schedule originally imposed by the District. These cost savings are quite likely to actually occur, but again, this is but one of several components that comprise the District's total cost savings estimate of 25 percent.

Administrative burden—The administrative burden for firms complying with the RECLAIM program will also vary. There was some concern early in the program development that monitoring and recordkeeping demands could prove too onerous for some, especially small businesses. (This might be especially problematic in a market for VOCs, which would include a larger number of small businesses.) Larger facilities, with numerous pollution sources to consider for control, typically have a greater resource base from which to operate and determine the best approach for operating in the market. Little information is available on whether RECLAIM places additional administrative demands on firms beyond those that already exist in the previous regulatory approach.

RECLAIM development and implementation proved a formidable task for District regulators. While no cost estimates were made (or available) prior to the undertaking, it quickly became one of the largest demands on District staff and other resources. The District Finance Division provided some cost data that showed that RECLAIM program development cost $0.9 million in FY 1991-92, $4.7 million in FY 1992-93, and $4.5 million in FY 1993-94. In addition, overtime hours paid for RECLAIM staff were some of the highest in the agency (147). This intensive effort and the associated burden on the District can probably be explained by the uncertainties involved in this program as a first-time major effort of this kind. They were breaking new regulatory ground with nearly every decision that had to be made.

RECLAIM permitting was split into two six-month cycles. Although there are 59 more Cycle 2 facilities than Cycle 1, District staff were able to cut the permitting time down by nearly one month through lessons learned and products created from the first round of permitting—which required 50 staff over a three-month period (147). With additional implementation experience the program costs for the District should decline as more of the resources are moved away from program development and applied to implementation and enforcement.

Fairness—Concerns for fairness in the design of the program are probably best revealed by decisions that were made regarding program participants, initial allocation of emission credits, and emissions reduction requirements. For example, initial plans for RECLAIM included a market for trading of VOCs. This market would have incorporated the largest number of facilities when compared to the much smaller number of sources considered for the NO_x and SO_2 programs. A high percentage of VOC emitters are small businesses, especially paint and finishing businesses. The District planned early to exempt some small VOC emitters—for example, dry cleaning facilities, restaurants, and gas stations—and some large sources, such as fugitive emissions at refineries and sewage treatment plants. This narrowed the list of possible sources from about 13,000 to approximately 2,000 (179). There was some concern that smaller businesses might be at a disadvantage in a market system, but good information on this subject is scarce. Members of the Small Business Coalition participated actively in RECLAIM development, and while concerns about program impacts never fully subsided, it is unclear whether there was a consensus opinion as to whether RECLAIM should be adopted or not.

It is no secret that the biggest firms (including oil companies, some aerospace firms, etc.) supported the RECLAIM concept from the start. Larger firms, typically owning facilities with many emission sources, had the most to gain from the added flexibility that a trading system would allow. The majority of the necessary NO_x and SO_2 reductions required by RECLAIM were already accounted for in previously adopted rules. Committing to additional reductions was an easy trade for gaining the flexibility allowed in the program. In effect, RECLAIM was a rule of relaxation for oil companies and utilities (174). Bringing other firms fully on board and working out the program details to make it fair for all involved was the real task.

One of the most controversial aspects of adopting RECLAIM was deciding the initial allocation of emission credits. The starting RTC allocation was significant for most businesses in that none would want to be penalized by their new emissions cap. One of the primary tenets of the Regulatory Flexibility Group (RFG)[5]—a business coalition—was that no business should start off “in the hole,” especially since all future reductions would drop from this allocation. There was significant concern that the initial allocation should not only allow for growth beyond recessionary levels of the recent past but should also account for previous application of pollution control equipment.

The District worked for an allocation methodology that was equivalent to adopted rules and the AQMP, and that was fair and equitable to firms. Their view of this meant that attention to fairness required allocation levels necessary to accommodate operating levels. The District finally selected an allocation approach based on “historic use” of each piece of NO_x and SO_2 equipment at a facility and subtracting the emission reductions necessary to comply with adopted rules.

While this method proved favorable to most of the participating firms, environmentalists contend that the initial allocation was too large and that it overcompensated for recessionary emission levels. They believe that the allocation is so high that the District will actually lose some progress made in the late 1980s and that it delays further progress to much later in the program. They believe that the initial allocation allows more pollution than would have been emitted in 1994-95 under the 1991 AQMP, and because of this, RECLAIM does not achieve reductions equivalent to the original plan. In effect, although RECLAIM is designed with an emissions endpoint equal to the AQMP, it does not account (or compensate) for the excess emissions in the early years of the program. Overall, environmentalists claim that RECLAIM is responsible for approximately 40,000 tons of additional emissions in the District (82,117). There is currently a lawsuit pending on this point.

Another fairness issue for the program developers was the rate of emissions reduction that would be required for each firm. Guided by future air quality standards that must be attained, the District had to limit participating facility emissions each year, including a specific reduction rate that would ensure that goals would be met. Initially, every facility was to make reductions at the same rate. It soon became clear that many firms felt this would be unfair, especially those that had already incorporated the best pollution control equipment. After a year of negotiation and remodeling with different proposed reduction rates, it was finally decided that there would have to be different final targets for each facility taking into account each facility’s current level of emissions and future control potential. Therefore, some firms have a fairly flat reduction schedule while emission limits for others drop off significantly (228).

VOC RECLAIM was deferred, in part, because the major oil companies realized in the end that they would be forced to make reductions that were not based on any known technologies (174). There was real concern that the reduction would have to be made in cuts to production levels, though the District did not feel that this would be necessary. Also, under the traditional regulatory approach, firms demonstrating best efforts to make reductions could often receive extensions to technology-forcing regulations if they could prove that it was impossible to comply. The loss of this option was considered unfair by the largest firms and they chose to oppose VOC RECLAIM (228). The CARB also continued to have concerns with the program because quantification of VOC emissions was not exact enough for trading.

Environmental equity and justice

Environmental justice concerns were an explicit part of the District’s environmental assessment of the RECLAIM program and possible alternatives, including the 1991 AQMP. Localized effects of VOC, NO_x, and SO_2 emissions and their addition-

[5] The Regulatory Flexibility Group is a coalition of businesses involved in RECLAIM development including firms such as Allied Signal Aerospace Co., ARCO, Chevron, Hughes, Mobil Oil, and the Walt Disney Company, among others.

al role as precursors to ozone and particulate matter were modeled and discussed extensively. Possible health impacts were especially contentious in VOC program development because of the potential for toxic emissions in this category and the possibility of contributing to toxic hot spots. The District will likely opt to exclude the most toxic substances (such as benzene, styrene, methylene chloride, and perchloroethylene). Moreover, air toxics will continue to be regulated under other programs that target them specifically.[6] The current delay in the VOC program has allayed, though maybe just temporarily, many fears about localized toxic impacts of trading.

One segment of the opposition to trading on the grounds of uncertain or negative health impacts due to RECLAIM was that of the environmental justice community. Although it was not a well-organized opposition, serious concerns were raised that some neighborhoods, especially low-income neighborhoods, would have worse air pollution than others. While this problem may not necessarily be aggravated by RECLAIM, opting for a trading system was in principle giving consent for some facilities to pollute more than others and forego greater emission reductions than could have been achieved. Although data are still limited in this area, many concerned with environmental justice contend that most polluting facilities are in or near poor and minority neighborhoods. For these groups, the risks associated with uncontrolled emissions are unacceptable.

Further, under RECLAIM, facilities do not need prior approval for trades; thus the opportunity for public participation is diminished. However, any action to install new equipment or increase emissions over the 1994 emissions cap is subject to review, and if the changes are significant, public notice is required. Beginning in 1996, the permitting requirements adopted under the 1990 CAA Amendments will require each whole facility permit to undergo public review and comment prior to being reissued. (This will occur every five years.)

To determine whether the fears of the environmental justice community were founded, the District analyzed whether areas with higher percentages of a given race (white, black, Hispanic, and Asian) experience higher levels of ozone exposure than areas with lower percentages. The District modeled both the correlation today and projections for the future under RECLAIM and the more traditional AQMP that RECLAIM was developed to replace. The study found that in 2000, RECLAIM would be somewhat better than the AQMP alternative, with regard to the distribution of exposures, for blacks, Hispanics, and Asians. RECLAIM would be slightly worse for whites than the AQMP alternative in 2000.

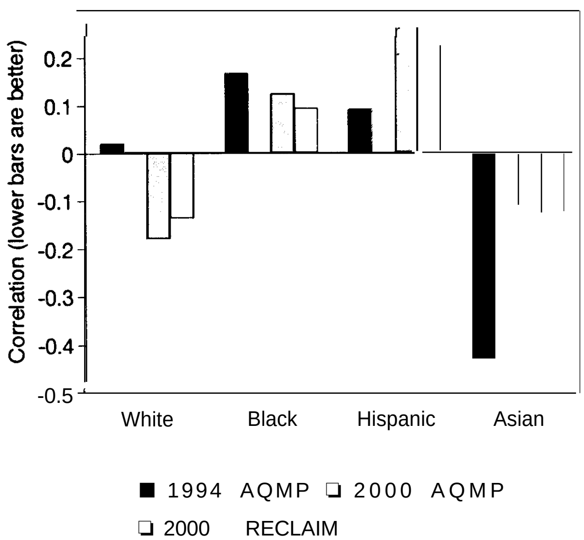
For this study, the measure of ozone exposure was the number of hours per year that people are exposed to ozone concentrations above the standard. In 1994, this was somewhat over 30 hours per year, on average, for all residents of the basin. By 2000, exposure under either plan is forecast to drop to below 20 hours per year. Figure 2-9 displays the relative distribution of exposure today and the forecasts under the two plans in 2000. The black bars show the distribution today. A bar greater than zero, that is, a bar above the line, means that an area with a higher percentage of that race is more likely to have higher ozone exposures than an area with a lower percentage of that race. Thus, in 1994, areas with the higher percentage of blacks were more likely to have higher exposures to ozone than those with lower percentages for blacks. The same goes for areas with higher percentages of Hispanics, but not as pronounced as for blacks. An area with a higher percentage of Asians was more likely to have a *lower* exposure to ozone than an area with a lower percentage of Asians (i.e., the bar is below the line).

[6] Including title III of the 1990 Clean Air Act Amendments and California's Air Toxics "Hot Spots" Act.

Two aspects of the two plans in the year 2000 are of interest. First, compared with each other, the distribution of ozone exposure is slightly more even under RECLAIM than under the more traditional AQMP alternative. Thus, if the modeling of the patterns of trades of emission credits is accurate, the feared aggravation of exposure to ozone in black and Hispanic areas is not likely, or at least not likely to be large. It is still true that there is less certainty about the distribution of ozone under the RECLAIM trading program, but the pattern of trades in this case may slightly favor black and Hispanic areas.

Another result is also striking, however. The changes between years is greater than the change between programs in 2000. Areas with higher percentages of Hispanics are more likely to be living in higher ozone areas in 2000 than they were in 1994. This does *not* mean that Hispanic areas will be exposed to more ozone in 2000 than 1994. As mentioned above, exposure to ozone drops dramatically throughout the basin. But in 2000, high Hispanic areas are more likely to be among the high ozone areas. RECLAIM improves the situation somewhat, but neither program-the more traditional AQMP regulatory program or RECLAIM—addresses the uneven distribution of exposure for Hispanics.

FIGURE 2-9: Correlation of Ozone Exposure and Race



SOURCE: South Coast Air Quality Management District, *RECLAIM: Socioeconomic and Environmental Assessment, Final Report* (Ill) (Diamond Bar, CA, October 1993).

Assurance of meeting goals

To balance the increased flexibility of the trading program, RECLAIM has required sources to improve emissions monitoring, measuring, and reporting. For larger sources of NO_x and $S0_2$, this means continuous emissions monitors. For smaller sources, this means continuous process monitors or fuel meters.

While industry expressed some concerns about the expense of continuous emissions monitoring for NO_x and $S0_2$, they were still generally willing to compromise in this area---especially since many of the larger sources already were or would be required to use CEMS under the current or proposed District rules subsumed by RECLAIM. A more contentious issue was the frequency of reporting this emissions information.

During the course of the compliance year, facilities are required to periodically report their emissions to the District. At the close of the first three quarters, facilities have a one-month period to certify their emissions for the quarter. At the end of the compliance year, facilities will be required to report their emissions and will be given a two-month reconciliation period to secure or sell any RTCs needed to "balance their emissions books" for the last quarter of the year.

A facility that exceeds its annual emissions allocation will be required to accomplish the reduction the following year and may be subject to monetary penalties. Facility permits may be revised (to include conditions to ensure future compliance) or possibly revoked.

Program-specific provisions to prevent "backsliding''—i.e., emission increases—may be proposed to the District Governing Board based on the findings of the annual or three-year audits to address specific program problems. Such provisions might include restricting trading, pre-approval of trades, enhanced monitoring, faster reduction rates, implementation of technology-specific emission controls, and increased penalties. In response to concerns that such "potential" backstops were not enough to ensure that RECLAIM would meet environmental goals, the District added provisions requiring reinstatement of rule limits in existing rules within six months of a report to the Board that either emissions or exposure to ozone increased by more than 20 percent above targeted values.

Another facet of assurance in meeting environmental goals under RECLAIM is how the program compares to the 1991 AQMP. Several environmental groups have argued that because the reduction rates for SO_2 and NO_x emissions are slower under RECLAIM, total emissions will actually be higher under RECLAIM. The District disagreed, primarily because RECLAIM sets mass emission limits on facilities, while the AQMP relied on setting emission rates—thus not preventing possible increases in emissions due to expanded work hours or facility expansion.

Many of the most strenuous objections to RECLAIM focused on the VOC trading program. The VOC trading market originally included all sources releasing more than four tons of organic compounds each year. This would have included about 2,000 facilities and about 85 percent of permitted emissions. Essential public services, restaurants, dry cleaners, and gas stations were exempted.

These facilities faced a 5-6 percent reduction cap each year. Fugitive emissions would be included in the facility baseline but the credit for reduction would only be given once standard, replicable methods to estimate emission reductions were developed.

In NO_x and SO_2 RECLAIM, the flexibility of the trading program was balanced by a more stringent monitoring system calling for CEMs for all major sources and continuous process monitors for all other sources. However, because it is so difficult to capture all VOC emissions, District staff felt that the available—and quite expensive—continuous monitors would not accurately reflect the total VOC emissions at a facility.

Instead, VOC monitoring would rely on tracking and reporting programs. VOC emissions would be calculated using flow characteristics of each facilities process, including the effectiveness of control equipment. VOC-containing products would be certified and labeled for VOC content and labeled for tracking. (A variety of tracking systems were proposed, such as bar codes and scanners, scannable forms, "credit cards," and telephone reports.)

Mass balance calculations would also be used (monitoring the amount of VOC product used), and the control equipment would also be monitored to determine effectiveness. District officials could use third-party records such as supplier invoices to check the permittees' reports. Finally, field inspections (checking that VOC content and label agreed and that control equipment was being used) would provide additional verification.

Environmental groups were hesitant from the start of the original VOC RECLAIM program. Monitoring was much more difficult than for NO_x or SO_2, and VOC emissions came from many more sources. Environmental groups were also worried that companies could easily falsify records and that enforcement would be difficult. They suggested phasing in VOC RECLAIM after the effectiveness of the first two trading programs was demonstrated. The District agreed that compliance issues were more complex for VOC trading but argued that it is possible to design transaction management systems—for example, barcoding drums of solvent—to improve emissions tracking and monitoring. In February 1993, however, the District agreed to postpone the VOC trading system.

Under the current plans, monitoring and reporting requirements would be streamlined and rely on monthly reporting of products used. The universe of facilities has been narrowed (to about 1,000) to include only VOC emissions from solvent, coating, and degreasing operations.

Emissions from solvent and coating operations are somewhat easier to quantify than, for example, fugitive emissions from refineries. In addition, better historical records are available for VOC usage, enabling the District to set somewhat less controversial allocations. The overall VOC reduction rate will be similar to that originally proposed—probably between 5 and 6 percent—but will vary by facility. For example, if a particular facility meets all "command and control" rules and the AQMP doesn't delineate further control code reduction requirements for the industry, a facility's reduction rate may be set at zero.

Facility-Wide Permitting in New Jersey[7]

Few other American states have had to deal with the combination of population density, industrial diversity and concentration, and a legacy of environmental degradation as has New Jersey. One of the state's most innovative initiatives for dealing with these problems has been an ambitious pilot program that links permitting with pollution prevention planning, primarily by moving from source-based permits to a single, facility-wide permit. As of April 1995, New Jersey has issued one final facility-wide permit, has at least two more close to completion, and has selected an additional 15 facility volunteers.

The initiative has two major components: planning and permit integration. Planning—central to achieving the goal of a 50 percent reduction in use, discharge, and generation of hazardous substances—is to be done in two parts. Part I requires each facility to generate essential planning data by identifying all facility processes involving hazardous substances governed by the statute and analyzing how those substances flow through the facility. For Part II, the facility develops a plan that targets processes and sources for prevention efforts by listing available prevention options, analyzes feasibility of the options, indicates those to be implemented, and establishes a set of numeric pollution prevention goals and measures for the next five years. More than 850 facilities are expected to participate in the planning component.

The second component creates a pilot program to link a facility's planning process to the integration of its environmental permits into a single permit. This would be a significant change from current approaches. At present, water permits are typically focused on facility-level releases, air permits on source-level releases, and hazardous waste permits at the process level for waste classification only. An integrated permit focuses on process-by-process information. Required for all three media, process information is drawn directly from the analyses conducted for facilities' pollution prevention plans. A process focus allows both the facility and state officials to examine issues for all media within each process and then integrate those views to create a facility-wide picture of releases and prevention options.

New Jersey's integrated permitting pilot project is best understood in its broader historical and programmatic context. The state for several years has responded to its environmental challenges with ambitious regulatory programs, many of which have served as models emulated by other states or the federal government (148,173). In response to delay and confusion over permit proliferation and fragmentation, the state over the past decade has developed several initiatives to improve permit coordination.

The state created an Office of Permit Information and Assistance in the New Jersey Department of Environmental Protection and Energy (DEPE), which convenes preapplication conferences and provides information. The Office of Business Advocacy in the Department of Commerce and Economic Development set up a one-stop construction permit identification program. Under this program, prospective applicants are asked to complete a form detailing their construction plans. The prospective applicants receive within 15 working days notification from the Office of all state construction permits that they will require, copies of all forms that must be completed, and the offer of a "permit expediter" who, if accepted, is to work on behalf of the proponent. Finally, legisla-

[7] Parts of this section are based on B.G. Rabe, "Integrated Permitting: Experience and Innovation at the State Level," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, June 1994.

tively mandated deadlines for permit issuance, discussed above, prod the DEPE and related agencies to churn out permit decisions within 90 days of application (8,83).

As is true with the use of such coordination mechanisms nationwide, these efforts are thought to have achieved some acceleration of permit decisions but have demonstrated little if any integrative capacity. In contrast, New Jersey has launched a series of integrative initiatives in recent years, including an ambitious program to link permitting with pollution prevention planning and move from segregated permits to a single, facility-wide permit. Such a step was initially proposed in the New Jersey legislature in 1989 and was approved and signed into law in somewhat modified form in August 1991. The New Jersey Pollution Prevention Act created an Office of Pollution Prevention within the DEPE and gave it authority to oversee both the pollution prevention planning and facility-wide permit processes (272).

How the Program Works

The planning process

Under this legislation, preparation of pollution prevention plans became mandatory for a large number of New Jersey firms. All facilities required to report under the federal community right-to-know program must, in turn, complete pollution prevention plans for the New Jersey Office of Pollution Prevention. More than 850 New Jersey facilities are thus expected to participate, developing plans that examine prevention options for all of the chemicals covered in the federal legislation. Facility-wide permitting was to be conducted on a pilot basis among individual industrial firms which had completed their plans.

The planning process is intended to provide "a source-by-source investigation of pollution prevention opportunities" conducted by each facility (8). The process is divided into two parts, with the first focused on generation of data essential to systematic exploration of prevention options. Firms are expected to identify all processes within a facility that involve hazardous substances specified in the legislation and analyze the way in which those substances flow through the facility. This is followed by identification of each process within the facility that involves hazardous substances and generation of inventory data for each process level. These data are essential to identification of sources that have been targeted for pollution prevention efforts (135).

The second part involves the formal construction of a plan to target processes and sources for pollution prevention. Each targeted process or source must be described and the quantity of nonproduct output (NPO) must be established for each source. NPO is defined as any hazardous substance that does not leave the facility in the form of a product of immediate commercial value or value when further refined elsewhere. NPO per unit of product provides a consistent annual measure of pollution prevention progress.

Once these assessments are completed, all participating facilities must list available pollution prevention options, including possible changes in procedures, technologies, and equipment, for each targeted production process and source. After completion of a feasibility analysis for each available option, the plan is to describe those pollution prevention options deemed technically and economically feasible.

Each facility must identify a series of five-year numeric pollution prevention goals. These include facility-level goals to reduce use and the generation of NPO for each designated hazardous substance as well as process-level goals to reduce the generation of NPO per unit of product for each hazardous substance within each targeted process.

Facilities must also provide an implementation schedule. These schedules are to include an anticipated construction start and completion date for each pollution prevention option (135).

The permit integration process

The legislation also called for creation of a pilot program to link pollution prevention activities with an integrated, facility-wide permit process. The Office of Pollution Prevention (OPP) was given authority to select from 10 to 15 firms and integrate each firm's many environmental permits and approvals into a single permit covering dozens, or in some cases hundreds, of traditional air, water, hazardous waste, and other permits. The ultimate product is a single facility document containing a summary of central aspects of the permit followed by separate sections, each of which examines the relevant permitting concerns for each production process.

Linking the process-by-process examination of hazardous substance flow completed for the pollution prevention plan to the permitting process allows both the facility and state officials to examine issues for all media within each process and integrate those views to create a facility-wide picture of releases and prevention options. However, the water permit program is currently focused on releases at facility level, the air permit program on releases at source level, and hazardous waste at a process level for waste classification only (136).

The New Jersey approach also allows greater flexibility for firms that want to make operational changes to accommodate new product lines and related adjustments. Under air quality preconstruction regulations, for example, holders of a facility-wide permit have an easier time than traditional permit holders having proposed changes deemed "amendments" rather than "alterations." Consequently, any proposed changes do not need DEPE preapproval as long as they do not increase the permitted concentration or rate of emission of any air contaminant for the production process or entire facility, NPO generation per unit of product, or the concentration or effluent limitations of any pollutant to surface waters (274). Observers of the New Jersey process contend that this flexibility is one of the main benefits to participating firms, in addition to increased ability to address major regulatory problems at a facility and public image enhancement through participation. However, these benefits differ considerably from case to case.

The permit application requires information in a very different form than for a medium-specific permit. Applicants are expected to provide both administrative and technical information on a process-by-process basis, including NPO per unit of product; air releases; discharges to surface water, ground water, and publicly owned treatment works; hazardous waste generation activities; and pollution prevention issues, such as cross-media transfer from operations and viable pollution prevention options developed in the pollution prevention plan. Much of this information can be drawn directly from the completed facility plan.

Once the application is received, the OPP coordinates activities of a Facility-Wide Permit Management Team. This team is to consist of representatives of all New Jersey program areas covered by the proposed permit and a representative of EPA Region II who will serve as a key contact for other federal officials whose input may be needed.

Public involvement procedures will follow the practices called for by the strictest individual permit, allowing for the longest required public comment period and earliest required public hearing. After this public involvement period, a final facility-wide permit is drafted by the permit team in consultation with individual program offices. A final period for internal agency review leads to permit issuance.

Early implementation experience

The DEPE launched its pilot program by deciding to seek only facilities willing to volunteer. Three such facilities were selected in early 1992 and formal agreements between the agency and the firms to work cooperatively on facility-wide permitting were signed in March. Two months later, similar agreements were signed with EPA Region II and agency headquarters. As these three facilities moved through the process, additional volunteers were sought. Twenty-six firms offered to participate and 15 were selected in December 1993.

One final facility-wide permit has been issued, with significant progress on at least two other permits. This experience to date suggests that the facility-wide permit concept is viable.

The issued permit is a for pharmaceutical manufacturing and research firm in Madison operated by Schering-Plough Corporation. This facility manufactures pharmaceutical products, including capsules, pills, asthma inhalers, ointments, creams, and their packaging, and has approximately 2,000 employees. Under traditional permitting approaches, the facility was required to obtain 897 permits just for air quality alone.

Under the integrated permitting approach, the entire Schering-Plough operation was broken into 31 separate production processes, each with its own section in the integrated permit. The OPP sent a preliminary permit draft to the company for its review in June 1994, and a final facility-wide permit was issued in late 1994. Overall, the process has proven to be more time consuming than anticipated but is generally perceived as both identifying numerous areas for pollution prevention advances and demonstrating the administrative workability of integrated permitting.

The two other initial pilot project selections continue to move through the various stages of the process. In Birmingham, Sybron Chemicals, Inc., provides a somewhat different test, since it is a more moderately sized facility. Nonetheless, the facility has previously been required to obtain more than 60 different permits for air, surface water, and ground water discharges and has encountered serious delays in some permit approvals. In the past, for example, Sybron has had to wait a full year in order to add or change just one air permit. Moreover, it had never before systematically explored the prospects for pollution prevention on a facility-wide basis, making it a good candidate for the pilot program (183). The final pilot case is Fisher Scientific, Inc., located in Fair Lawn, which is a specialty chemical manufacturing facility. After some delays due to changes in company leadership, Fisher completed its plan and submitted it to OPP in June 1994. One permit team has been assembled to work on all three cases, with members from OPP, EPA Region II, and all relevant DEPE programs.

The experience with these three cases was sufficiently encouraging for OPP to pursue the upper boundary of its legislative mandate by selecting 15 additional volunteer facilities. The planning and permitting processes are beginning with all of these facilities, which were selected on the basis of criteria set forth in the legislation. These criteria included facility size, number and types of permits, number of hazardous substances, permit expiration dates, existence of cross-media issues, and types of enforcement issues. The OPP also sought applicants with a strong track record of regulatory cooperation, although this was not part of the formal criteria.

The legislation calls upon the DEPE to issue permits for each of these facilities by August 1995. In March of the following year, the DEPE is required to prepare a report for the governor and legislature that analyzes the facility-wide permit program.

New Jersey's Integrated Permitting and the OTA Criteria

New Jersey's integrated permitting experiment sought to improve a facility's use of pollution prevention approaches and to increase the facility's ability to adapt quickly to new product or process opportunities. The following sections briefly review how the program intends to further these two criteria.

Pollution prevention

The New Jersey program illustrates the potential for linkage of facility-wide pollution prevention planning with integrated permitting. Unlike most states, in which pollution prevention planning operates largely independently of permit decisions, New Jersey blends the two together in an effort to maximize opportunities for pollution prevention. By combining permitting with other aspects of the state's pollution prevention program, such as technical assistance, the state may be offering a package that is appealing to industry and will lead to significant pollution prevention gains.

The state's early experience in combining pollution prevention planning with a facility-wide permit in a small number of cases illustrates some of the potential changes that can ensue. For example, this process led to the discovery by officials of the Schering-Plough pharmaceutical plant of significant amounts of a hazardous substance, 1, 1, 1 Trichloroethane, that were being released into the air.

Review of a process for cleaning equipment used to manufacture asthma inhalers found that it generated fugitive emissions five times greater than levels allowed for the entire facility. The integrated planning and permitting processes found the leaks and devised a delivery system that has virtually eliminated them.

By concentrating at both the facility level and within individual processes, the New Jersey approach generates a more coherent picture of what is transpiring within facility walls and what opportunities for prevention exist. The 897 air quality permits that were formerly required of the pharmaceutical facility were compressed into a single permit that divides the entire facility into 31 separate processes. The overall emissions reduction goals of the pollution prevention plan requirements make clear that the state is serious about achieving major gains. In turn, the integrated process creates an opportunity to make that transformation as easy as possible for the regulated party.

New Jersey officials noted that the experience has also elevated awareness of pollution prevention opportunities among their DEPE colleagues. By participating in an integrated site visit and jointly reviewing draft plans and permits, officials from fairly narrow regulatory backgrounds get what may be their first opportunity to take a broader look at a facility. This allows them to examine the facility's particular environmental problems and target areas where significant gains can be achieved.

Adaptability to change

New Jersey's initial experiences indicate some potential for integrated permits as an adaptable alternative to traditional permitting. The permits incorporate a range of allowable changes that the state agency and facility could anticipate during permit development. Facilities believe that the process-based integrated permit will allow them far greater flexibility to accommodate new product lines and other changes in a speedy enough manner to take advantage of changes in market conditions.

However, the substantial time and resources expended to issue an integrated permit that incorporates individual permits—sometimes hundreds—highlight the potential difficulty of reopening and amending an existing integrated permit. The first integrated permit New Jersey issued took approximately three years to develop and finalize. The state anticipates significantly shorter development periods for future integrated permits. Nonetheless, the potential delay could be a barrier to adaptability, if the state and facility wish to modify a permit because circumstances or technologies have arisen that were not anticipated.

Proposition 65 and the California Air Toxics "Hot Spots" Program

Two information reporting programs in California illustrate the strengths and weaknesses of this instrument with regard to our three "environmental results" criteria: 1) assurance of meeting environmental goals, 2) pollution prevention, and 3) environmental equity and justice.

The Safe Drinking Water and Toxic Enforcement Act, otherwise known as Proposition 65, was adopted in California as an initiative on the ballot in the November 1986 elections (270). The law's primary goal is to lower the risk to human health and the environment associated with exposure to toxic chemicals. It attempts to achieve this goal through the increased availability of information on toxic chemical use and releases as an incentive for industry to remove nonessential carcinogens and reproductive toxins from its products and processes. The law covers both consumer products and facility discharges. It focuses on estimates of risk to human health, rather than the more common, but harder to interpret, reporting of emissions.

Another information-based program in California combines information reporting, risk assessment, and public notification in a law that also works to identify and control public exposure to air toxics. The Air Toxics "Hot Spots" Information and Assessment Act of 1987 established an emissions reporting program to inventory statewide emissions of more than 700 toxic substances

(272). The law further requires identification and assessment of localized risks of air contaminants and provides information to the public about the impact of those emissions on human health.

How the Programs Work

Proposition 65

On the books, Proposition 65 is a fairly simple law, spelled out in two basic steps. First, it requires the governor of California, in consultation with scientific experts, to compile a list of chemicals known to the state to cause cancer or reproductive toxicity. Second, it places two restrictions on these chemicals: 1) businesses should not knowingly and intentionally expose an individual to any one of the listed chemicals without first providing a clear and reasonable warning, and 2) businesses should not discharge any one of those same chemicals into any current or potential source of drinking water.

The law recognizes that at some level the risk posed by these chemicals will be *de minimus.* Thus, no warning is required if the amount of the listed chemical present in ambient environmental exposures, exposures from consumer product use, and discharges into current or future sources of drinking water fall below a level which would pose "no significant risk" for carcinogens (i.e., one excess cancer in 100,000 humans exposed over a 70-year lifetime at that level) and below a 1,000-fold safety factor of the "no observable effect level" (NOEL) for reproductive toxicants.[8]

Currently, the list of chemicals for the purposes of Proposition 65 includes 542 chemicals (392 carcinogens and 150 reproductive toxicants). Of the listed chemicals, 274 have "no significant risk" levels assigned and eight reproductive toxins have the 1,000-fold safety factor of the "no observable effect" level (NOEL) assigned.

Enforcement of Proposition 65 is carried out by the state attorney general, district attorneys, some city attorneys, and private citizens. Proposition 65 requires the plaintiff to demonstrate that a regulated business caused a "knowing and intentional exposure." It is then the responsibility of the business (the defendant) to prove that the extent of the exposure did not exceed the levels allowed by the law.

"Hot Spots"

Each air pollution control district in California implements the "Hot Spots" Act through a four-step process. In the first stage, all permitted facilities were required to prepare and submit an air toxics emissions inventory to the District office. Facility reporting requirements were phased in based on the quantities of other air pollutants they emitted.

The second stage requires District offices to use the emissions inventory data to rank facilities in high, intermediate, and low priority categories to determine the need for risk assessment.[9] Priority is based on a number of factors including the amount of contaminants emitted, relative potency and toxicity of the contaminants, and the proximity of facilities to nearby communities. Once classified, only high priority facilities trigger further program requirements. Designation as a high priority facility, does not necessarily mean that nearby populations are at increased risk from air emissions. Instead, it is an indication that further assessment of the facilities emissions is needed.

In the third step, all high priority facilities are required to prepare health risk assessments to measure the adverse health effects that may result from exposure to a facility's emissions. The California Office of Environmental Hazard Assessment provides risk assessment guidelines that assist facilities in the process. Additional notifica-

[8] Note that: 1) Proposition 65 does not apply to businesses employing fewer than 10 employees; 2) the law does not apply to government agencies; and 3) the law does not apply to drinking water utilities.

[9] As defined by the Air Toxics "Hot Spots" Act, a risk assessment includes a "comprehensive analysis of hazardous substances into the environment, the potential for human exposure, and a quantitative assessment of both individual and population-wide health risks associated with those levels of exposure."

tion and risk reduction requirements vary with the level of risk assigned to each facility. In the final stage, facilities presenting a significant health risk are responsible for notifying exposed individuals of the results of the health risk assessments through direct mail or a public hearing.

The law further requires public access to all emissions data and health risk assessments that are currently available through the state-managed Air Toxics Emission Data system. In addition, each of the air pollution control districts prepare annual reports summarizing the health risk assessment program, ranks facilities according to cancer risk posed, identifies facilities posing noncancer health risks, and describes the status of control measures.

Proposition 65 and "Hot Spots" and the OTA Criteria

A key question about information reporting programs is whether or not they can be as effective as more traditional approaches in achieving environmental results. Thus, in this case study, we focus on the following OTA criteria: 1) assurance of meeting environmental goals; 2) pollution prevention; and 3) environmental equity and justice.

Assurance of meeting goals

The primary goal of Proposition 65, as stated in the legislation, is to lower the risk associated with human and environmental exposure to toxic chemicals. To accomplish this, the state defines a level of "acceptable risk" for the potential of cancer or reproductive disorders for state-listed substances. By requiring a warning when "acceptable risk" thresholds are surpassed, the law creates an incentive to avoid the need to warn by lowering or eliminating the risk of exposure.

Setting levels of "acceptable risk" assumes that risk can be reasonably accurately estimated—a particularly difficult and contentious activity for government agencies and regulated entities. In the case of Proposition 65, the absence of risk levels does not halt the implementation process. Instead, a listed chemical in any quantity is considered unacceptable at any level (requiring clear and reasonable warning) unless proven otherwise. This aspect is referred to as a shift in the "burden of proof" from the regulator to the regulated and is often credited with the fact that many more *de minimus* risk levels have been established for specific chemicals than were accomplished in 12 years of TSCA (157). Therefore, although Proposition 65 includes risk-based goals, assessments of actual risks by government officials are not needed in order to protect against harm due to listed chemicals.

Proposition 65 is likely to meet its environmental health goals in at least some instances. Again, the law requires a warning if risks exceed what is considered an unacceptable level. The potential for negative public perception of the offending firm or consumer product may inspire changes that reduce pollution associated with production or product reformulation, thereby reducing risks from exposure. Thus, though the public cannot be assured that the law's environmental health goal will be met in *all* cases, it is likely to be reached in *some* cases.

Proposition 65, however, may be less successful at assuring the public that environmental goals "have been met." This is because there is no centralized reporting of actions taken. The state does not collect basic information, such as the number of or reasons for posting or removing warnings or labels; nor does it monitor for violations to the law. Most evidence of pollution prevention activities under Proposition 65 is gathered indirectly through letters from manufacturers to distributors concerning reformulations of products or chemical substitutions, or from enforcement actions (often involving reformulations of products), indicating that some level of toxics use reduction does occur. However, since businesses are not required to provide any information about their activities (125), the extent of risk reduction due to the law cannot be adequately estimated.

Monitoring and enforcement are critical for assuring the public that environmental goals have been met. In the case of Proposition 65, violations can only be identified through its overlap with other environmental laws that require some reporting of toxic emissions (e.g., California's Air

Toxics "Hot Spots" program and the national Toxics Release Inventory). For consumer products, contents not regulated by the Consumer Product Safety Commission or the Food and Drug Administration must be traced to the production process. Since this information is not widely known outside the facility, enforcement opportunities are limited.

One attempt to improve enforcement of the law is the citizen suit provision, including the "bounty hunter" allowance that awards citizens bringing successful enforcement actions 25 percent of the total fines collected. Violations of Proposition 65 carry civil penalties that allow for fines at a maximum of $2,500 per day for each violation. In theory, by allowing citizens to keep part of the fines assessed through enforcement actions, more help from the general public will be enlisted.

The "Hot Spots" program is particularly instructive from the perspective of "assurance of meeting environmental goals." Similar to Proposition 65 in some ways, "Hot Spots" focuses on risk associated with toxic emissions and, in cases of unacceptable risk levels, provides for public notification. However, the law goes further by requiring facilities to report toxic air emissions both to the state and to exposed individuals through direct mail or a public hearing. Equipped with emissions data records, the state is able to analyze changes over time in order to better evaluate the impact of the law. And with emissions data, others can check whether the law's risk threshold is exceeded. As with Proposition 65, there is little assurance of knowing in advance that environmental goals *will be* met. However, compared to Proposition 65, the "Hot Spots" emissions inventory provides a significant advantage in determining if environmental goals *have been* met."

Thus, the "Hot Spots" program, as a pure information program, did not provide the desired level of assurance that the environmental goals will be met. Concern over the lack of "teeth" in the program resulted in statutory amendments to the act in 1992 requiring all significant risk facilities to reduce the identified risk below the level of significance. Within six months of designation, facilities must submit a risk management plan that reduces the associated risk within five years.

Pollution prevention

Clearly, one approach to meeting the Proposition 65 goal of reducing risks associated with toxic chemical exposure is to eliminate or reduce the need for the chemicals from the start. In analyzing the link between policy instruments and the promotion of pollution prevention behavior, it is important to consider two important aspects: 1) whether the tool in some way gives an advantage to prevention, and 2) whether the tool encourages organizational learning about prevention. The second aspect attempts to encourage pollution prevention indirectly by changing a firm's culture so that decisionmakers and employees will routinely incorporate pollution prevention practices. The effectiveness of Proposition 65 for pollution prevention is best understood by considering the different impacts on ambient environmental exposures (including facility discharges and workplace exposures) and consumer products.

In the event that exposures surpass allowable risk levels, firms have the option to provide a "clear and reasonable warning,"[10] or reduce or eliminate the toxic chemical from the production process or the facility emission. Proposition 65 works to encourage firms to lower the risk associated with the listed chemical so as to not have to comply with the warning provision.

However, a firm does not have to use pollution prevention activities to reduce or eliminate a toxic chemical. In the case of ambient environmental exposures, Proposition 65's ability to promote pollution prevention is probably neutral—neither encouraging or discouraging pollution prevention. A firm may choose additional pollution control, rather than source reduction, and still avoid a

[10] This does not apply to toxic discharges to water which are strictly prohibited at levels greater than the "no significant risk" or 1/1000 NOEL.

warning. Changes made to the listed chemicals through pollution prevention is the hope, but not necessarily the reality.

Proposition 65 may indirectly promote pollution prevention through the educational role it plays, but this too is unclear. One impact on the regulated community has been an increase in environmental auditing efforts in order to determine compliance with the law. A survey conducted by the California Environmental Protection Agency in 1992 shows that 31 of the 55 respondents did perform audits targeted for Proposition 65 listed chemicals (27). Businesses are concerned with identifying where in their production processes listed chemicals are used and in doing so may make decisions to incorporate pollution prevention practices in order to lower the risks from exposures. Proposition 65 does provide incentives for increased awareness of toxic chemical use, but how much this actually translates into pollution prevention activities is unknown.

However, Proposition 65 does provide a direct incentive for using pollution prevention to reduce risks associated with toxic chemical exposure from consumer products. The primary method to reduce these risks is to eliminate listed chemicals from consumer products whenever possible. Otherwise, the manufacturer must place a warning on the product label if risks associated with its use surpass those allowed by the law. Presumably, some consumers will be discouraged from buying a product carrying a warning label if alternatives are available. Once listed chemicals are removed from the product formulation, reducing the risk to legal levels, the manufacturer may remove the warning label.

A related aspect concerning pollution prevention under Proposition 65 is the use of enforcement actions to force changes in polluting behavior. Though enforcement actions have been relatively few to date, many settlements negotiated thus far have required pollution prevention efforts by the violator. Some settlements have required reformulation of consumer products, for example, one that led to reformulation of liquid correction fluids (28).

Arriving at a clear picture of pollution prevention under Proposition 65 is complicated due to: 1) the lack of baseline information about toxic chemical use; 2) the absence of mandatory reporting of compliance activities; and 3) the overlap with other environmental laws that also affect polluting behavior. Ultimately, while both direct and indirect incentives for pollution prevention exist in theory, the actual level of prevention is unknown.

Environmental equity and justice

Although Proposition 65 was enacted in 1986 primarily as a result of general concerns about public access to information about toxic chemicals in the environment, it has some unique qualities that make it interesting from the perspective of environmental equity and justice. One important feature of any information reporting program is the *nature* of the available information. Depending on the purpose, information may exist in many different forms, including raw data about polluting activities such as that found in the Toxics Release Inventory. Through its warning provision, Proposition 65 brings a different type of information to the public.

Rather than focus on quantities of pollutants, Proposition 65 makes available information about the risk associated with products and activities of regulated entities. The warning sign or label stating the presence of toxic chemicals known to the state to cause cancer or reproductive disorders needs little further interpretation. The hard part of determining whether exposures to the product or emission are hazardous to human health or the environment has been previously determined by another party—those responsible for the exposure.

It is, of course, helpful to interested individuals to have immediate access to information about a potential problem associated with the presence of a toxic chemical. However, even with this new level of risk-based information, individuals typically have little ability to make sense of the risks associated with multiple or synergistic impacts of toxic chemical exposure. In addition, there is no way to determine whether the level of risk is only slightly above the warning threshold, or very much above it. This limitation, while not unique to Proposition 65, diminishes the value of the information for certain communities that may be more heavily affected by ambient environmental exposures to toxics.

Although the risk-based warning provision does not provide a complete picture of the hazards from toxic exposures, the information is immediately accessible, thus removing at least some of the hurdles facing people who would like to become more involved. In theory, increased information about risks from nearby facilities or from consumer products might motivate action on the part of some—including regulators—to work for change, such as pursuing new legislation or additional regulations (e.g., toxics use reduction laws and special air toxics programs) (70). In the marketplace, the additional information about toxic chemicals may change consumer purchases, favoring products without warning labels over those that carry the state-required warning. The advantage of increased awareness of the presence of toxics provides an added opportunity for all communities to work toward greater protection from environmental and human health risks.

While Proposition 65 does provide a mechanism for increasing public awareness of risk, it does little to insure that all communities will receive the same level of protection from toxic chemical exposures. The built-in incentives to reduce potential toxic exposures rather than manage negative public opinion due to warnings may prove beneficial, but without data on actual reductions assessing the gains made in specific communities will be difficult. In addition, it is unclear whether the additional information gained through Proposition 65 is enough to engage effective public participation, especially in the absence of institutional support for citizen lawsuits. Thus, information reporting about environmental risks may be inadequate for addressing risk concerns in some communities.

Proposition 65 shifts the burden of proof of risk due to toxic exposures from the regulators and the public back to the businesses. To avoid having to post warnings, businesses must re-examine their processes or products for risks associated with the use of toxic substances. Businesses must also quantify the risks associated with listed chemicals and show that they fall below the *de minimus* level or warn instead. Proving that an exposure or emission poses a significant risk is not the responsibility of the citizen. In addition, the bounty hunter provision supports citizens' efforts to protect their communities by making available compensation for pursuing enforcement actions when violations are suspected. Such compensation may be particularly important in low-income communities.

Massachusetts Office of Technical Assistance (MassOTA)

The Massachusetts Office of Technical Assistance (MassOTA) is one of the nation's largest technical assistance programs for promoting pollution prevention, although there are other well-known programs—in North Carolina and Minnesota—that have been operating longer. MassOTA was created in 1989 by the state's Toxics Use Reduction Act (TURA), one of the foremost pollution prevention statutes in the country (172). TURA has the following goals:

- to reduce statewide generation of toxic wastes by 50 percent by 1997;
- to establish toxics use reduction as the preferred means for achieving compliance with any federal or state law or regulation;[11]
- to enhance and strengthen the enforcement of existing environmental laws and regulations; and

[11] Toxics use reduction is defined in the Act as "in-plant changes in production processes or raw materials that reduce, avoid, or eliminate the use of toxic or hazardous substances or generation of hazardous byproducts per unit of product . . . without shifting risks to the health of workers, consumers, or the environment."

- to "sustain, safeguard and promote" the competitive advantage of Massachusetts business, while advancing innovation.

The Act established a Council on Toxics Use Reduction and an external Advisory Board on Toxics Use Reduction in the state's Executive Office of Environmental Affairs (EOEA) to advise and coordinate the toxics use reduction activities of three agencies created:

- the Bureau of Waste Prevention (BWP), within the Department of Environmental Protection (DEP) to monitor and enforce compliance;
- the Toxics Use Reduction Institute (TURI), located at the University of Massachusetts-Lowell to support industry efforts through research and development of alternatives and to educate and train students, especially Toxics Use Reduction Planners who certify facility plans; and
- the Office of Technical Assistance (MassOTA), incorporating the former Office of Safe Waste Management in DEP and its technical assistance functions.

The Massachusetts TURA is considered to be the most comprehensive and stringent compared to those in similar states (185). It requires qualifying facilities or "large-quantity users"[12] to report annually on toxics use, both total amounts and a "byproduct reduction index" based on changes in use per unit of production. Users also must prepare two- and five-year facility-wide reduction plans, submit summaries of these plans to DEP, and update the plans every two years.

After reviewing the data submitted, DEP must provide the legislature with an estimate of whether the state will meet the reduction targets. If necessary to meet the targets, DEP has the authority to set performance standards by user segments. These plans can also be used by the Council to select "priority user segments" for special attention, including referral to MassOTA for technical assistance.

What MassOTA Does

Under TURA, MassOTA is responsible for providing technical assistance to toxics users in the state. It offers confidential onsite assessments, conferences and workshops, financial analyses, and written information on toxics use reduction techniques and technologies. Funded out of fees from facilities subject to TURA, MassOTA now has over 30 staff members and an annual budget of over $4.1 million (139). The average size nationally for technical assistance programs engaged in pollution prevention efforts is about four or five staff members (197).

TURA requires MassOTA to assist *all* toxics users in Massachusetts, including small quantity users not subject to TURA reporting and planning requirements. Thus, MassOTA's client base includes all types and sizes of manufacturing firms, as well as nonbusiness organizations and others such as schools, government agencies, hospitals, and residents.

TURA does require MassOTA to give priority to some types of users, especially those referred by DEP for compliance problems. However, TURA prohibits MassOTA from disclosing to the DEP firm information it obtains while providing technical assistance, in part to encourage trust between MassOTA and firms needing assistance.

MassOTA was also required to set up an outreach program to increase compliance with TURA. The agency, with TURI and DEP, sponsored a series of workshops on technical assistance, including three for selected industry sectors, between 1990 and 1994, reaching 133 facilities (or 21 percent of TURA filers). Overall, MassOTA estimates that it has reached about half of the 630 facilities required to report under TURA.

MassOTA has also made onsite visits to about 400 companies out of the 10,020 hazardous waste generators operating in Massachusetts. Five teams of three engineers respond to requests for

[12] Large quantity users exceed the facility threshold (25,000 lbs/yr) for use, manufacture, or processing of a toxic substance. Toxic substances are those defined by CERCLA.

technical and compliance assistance. Based on a site visit by one or two team members to assess a firm's manufacturing processes and identify existing or potential environmental problems, MassOTA staff prepare a report suggesting opportunities for reducing toxics use and additional solutions, including estimates of costs. This type of service, requiring about nine weeks to complete, is normally provided on a "first come, first served" basis, although the agency can give priorities to others if necessary. For example, firms that are TURA filers or DEP referrals may get preference.

MassOTA has not completed a systematic evaluation of its services. However, the agency did fund an independent evaluation of the Central Massachusetts Pollution Prevention Project (1989 to 1992), a technical assistance program focused on metal-intensive industries and jointly funded by EPA's Office of Pollution Prevention, MassOTA, and DEP. The objectives of the project were to:

1. expand the existing technical assistance program;
2. coordinate activities with DEP and local sewage treatment plants;
3. develop a financial feasibility model to enable company managers to determine the cost-effectiveness of pollution prevention options; and
4. share information and coordinate with other technical assistance programs in New England.

MassOTA contracted for an evaluation at the end of the project that compared the performance of the project's target group of 62 firms to the control group of 48 firms not included in the project. The evaluation reported three major conclusions:

- *Firms who got technical assistance services were more likely to reduce use of toxics.* Of the 110 firms included in the evaluation, about half (51 percent) reported reducing their use of toxics. Twenty-seven (87 percent) of the 31 firms using MassOTA services reduced toxics use, while only 26 (or 33 percent) of the remaining 79 firms that did not receive technical assistance services reported doing so. This outcome may reflect the fact that firms contacting and using these services are somewhat predisposed to making changes.
- *The amount of reductions was significant and affected all media*. Twenty firms in the project with sufficient data to evaluate had overall reductions of about 75 percent of all TURA listed substances.
- *Cost savings to the firms were also significant and considerably more than the state's costs of operating the project.* Although MassOTA could document data from only seven firms, their average cost savings from toxics use reduction was about $35,000 per company per year.[13] Savings from these seven firms alone—$250,000 per year—were greater than the cost of the Central Mass Project of $174,000 per year. Additional savings from the other 13 firms in the project that documented toxics use reduction would likely increase this benefit/cost ratio considerably.

MassOTA and the OTA Criteria

Of the seven criteria used in this OTA study on policy instruments, two are highlighted in this case study on technical assistance: 1) adaptability and 2) technology innovation. One other, pollution prevention, is relevant because MassOTA was established to provide assistance with toxics use reduction, a prevention strategy. But the reality is that, while TURA issues are given priority, MassOTA services are not exclusively devoted to them.[14]

An unknown percentage of time spent by MassOTA staff providing crisis assistance, helping a

[13] While firms rely on estimated cost-savings information to approve a project, they apparently do not always document their actual savings record after implementation is completed.

[14] This is true of many pollution prevention technical assistance programs. U.S. Congress, General Accounting Office, *Pollution Prevention: EPA Should Reexamine the Objectives and Sustainability of State Programs*, GAO/PEMD-94-8 (Washington, DC: January 1994).

regulated entity solve a particular enforcement or compliance problem. The outcome may or may not be toxics use reduction. Often, this assistance is considered a way to "get a foot in the door" to start the development of a relationship with a firm. The hope is that at a later date the firm will become more receptive to pollution prevention. There is anecdotal evidence to suggest that this conversion does happen, but how frequently or quickly is unknown.

Adaptability

One reason for choosing instruments with less direct control is that they can be relatively easily adapted to incorporate new information and approaches for solving environmental problems. MassOTA, as a service unit rather than a regulatory agency, can be oriented toward understanding the changing needs of its clients and learning from its interactions with a range of facility personnel across the state. Another key reason for using this instrument is that those firms needing assistance can seek it, while those able to solve problems independently are free to do so.

Like most technical assistance programs, MassOTA is a service organization that usually works with its clients or firms on a one-on-one basis. Even without formal feedback and evaluation, this continual contact gives MassOTA staff a sense of the changing needs of its clients. And, while MassOTA's broad responsibilities are statutory, it has the authority to change its methods of service delivery and improve the quality of information it provides on a continuing basis.

The lack of regulatory power and the prohibition on disclosing firm information to DEP could help MassOTA gain the trust of the business community. The implied threat of future performance standards under TURA, should targets not be met, may also encourage some firms to use the services.

MassOTA explains the dynamics of technical assistance in the following way: "Pollution prevention is a rapidly changing field and [Mass]OTA must adjust its services as new technology evolves, the business climate changes, and regulations at all levels of government affect the production choices of industry (139)."

Though changing environmental regulations can be problems for regulated entities, they are opportunities for MassOTA. The Oregon Department of Environmental Quality concluded that by targeting "windows of opportunity" within the regulatory system—that is, when firms are required to make changes—firms may be more open to new ideas, especially when economic savings can be projected (141). Such an opportunity was exploited by MassOTA recently by sending a letter to all facilities on DEP's air regulatory database informing them that hexane was about to be added to the TRI list and offering technical assistance services.

MassOTA's efforts to make its services more effective for clients can be seen in its revisions in staffing and its site-visit consultation process following early experiences through the Central Mass Project. For example, MassOTA ended its experiments using student interns and volunteer consultants in favor of using permanent, professional staff. It also abandoned the use of lengthy, written site-visit reports in favor of short, three-page written follow-up reports outlining specific solutions. Other changes included the addition of a financial analysis process for client firms and a software system for tracking internal progress.

Technology innovation and diffusion

The primary purpose of MassOTA is to diffuse known technologies among industries in the state and to help firms make needed innovations to existing technologies to fit their particular needs. By focusing its efforts on small firms with less capability to innovate or adopt technologies on their own, MassOTA is following the recommendations of many experts regarding the most effective use of technical assistance programs. In addition, by creating direct links among experts in various industries and in government or research institutions through onsite visits, seminars, and workshops, MassOTA has attempted to keep both formal and tacit knowledge at state-of-the-art levels.

Staff members keep up to date on new techniques and technologies and, as experts in particular sectors, serve as "in-house" consultants to one another. The organization offers periodic "technology transfer days" during which technical staff more formally exchange technical information among themselves. During these sessions vendors often present their products, offering staff an opportunity to learn, critique, and evaluate.

At the same time that they are delivering services, MassOTA staff often learn from the firm as well, collecting and eventually diffusing technical information across the firms that they serve. This diffusion can be somewhat constrained by confidentiality rules. The information in onsite reports written by MassOTA is available only to the firm involved. However, general ideas resulting from its work with a firm can be transferred to others. Case studies, based on onsite work and written in cooperation with the subject firm, are published by MassOTA and disseminated as a way to promote reduction of toxics use.

Most of MassOTA's work involves diffusion of known technology among Massachusetts' industry. Since the state's industry base is generally mature, MassOTA's director classifies its needs as "adaptations of existing technology," labeling these innovative in the sense that they often require incremental changes in the technology to fit a use not previously identified. MassOTA does not seek a major role as a stimulator of new technology development by either regulated entities or the environment industry.

The technological expertise of MassOTA is embodied in its staff, who come primarily from industry and are knowledgeable about manufacturing processes. Diffusion occurs from staff to Massachusetts' industry through its on-site and other work directly with clients, written products such as case study fact sheets, and workshops. The staff are organized in teams on the basis of geography rather than by industry sector.

The Toxics Use Reduction Institute (TURI) at the University of Massachusetts-Lowell is responsible for supporting MassOTA efforts through technology research and development (R&D). This institutional and geographic separation of R&D capacity from outreach capacity stands in contrast to the model experts agree is most effective—physically linking the R&D and outreach staff to improve interaction and problem solving. The directors of TURI and MassOTA have made staff coordination and information sharing a priority in order to overcome this potential barrier to effectiveness.

Although not all states fund the R&D function, some that do have linked it more closely to the technical assistance service unit. For instance, the Illinois Hazardous Waste Research and Information Center (a division of the Department of Energy and Natural Resources) offers onsite pollution prevention technical assistance and has an R&D budget (about $800,000 of an annual $2 million budget). Some other states have small grant programs for technology development.

Congress' Environmental Policy Toolbox: A Review 3

Environmental goals can be reached in many ways. Some ways are quite prescriptive, others are not. If one imagines a typical factory as having one or more pollution sources, it is easier to think of the many options available to Congress, EPA, and the states. Raw materials and products go into the factory, manufacturing processes within the factory are used to produce new products, and often some "nonproduct" residual—pollution—is generated and released to the air or water, or shipped offsite for disposal, treatment, or storage. Sometimes the product itself results in pollution, while or after it is used.

To lower the pollution reaching the environment, government can—

- specify the end result—the amount of pollution that each source in the facility is allowed to discharge;
- specify what the source is to do to achieve the end result, such as install certain kinds of pollution control technology;
- help the source through a technical assistance program or a subsidy for cleaning up;
- specify the end result for each source, but allow facilities to trade these requirements within or among facilities;
- charge a fee on pollutant emissions[1] to discourage releases to the environment;
- require only that the source publicly report emissions or risks to the human health and the environment;

[1] "Emissions" is a term typically used for pollutants released to the atmosphere, while "discharge" is the term used for pollutants released to water bodies. To avoid repetition of both words, this assessment uses the word "emissions" to denote releases of any type of pollutant to air, water, or land.

- require nothing in particular but hold sources liable for any resulting damages;
- or, as is often the case, some combination of two or three of the above.

All of these approaches are policy instruments, the topic of this OTA report. They are the means through which government encourages or forces sources to achieve society's environmental goals. Each of these policy instruments or tools has inherent strengths and weaknesses. Some address particular types of pollution problems better than others. Yet picking a tool does not merely involve identifying those that reduce emissions. Instrument selection also involves tradeoffs between values and interests commonly held by Congress and the public. For example, instruments most likely to provide significant assurance that an environmental goal will be met are equally likely to achieve that goal in a manner more expensive than some other instruments. A full toolbox allows the decisionmaker to select tools that most effectively address values and interests of particular concern at the moment. And combinations of complementary instruments may allow decisionmakers to address multiple concerns or to shore up weaknesses in a particular instrument.

Environmental policy tools could be categorized in any number of ways, depending on which attributes one wishes to emphasize. This assessment groups 12 tools according to whether or not they have fixed pollution reduction targets. Such a focus helps the decisionmaker address a common concern in environmental policy, namely, the extent to which particular behavior is mandated by regulation. Table 3-1 provides brief definitions of each of the tools discussed in this assessment, including:

- Tools with fixed pollution reduction targets:
  1. harm-based standards
  2. design standards
  3. technology specifications
  4. product bans and limitations
  5. tradeable emissions
  6. integrated permitting
  7. challenge regulation
- Tools without fixed targets:
  8. pollution charges
  9. liability provisions
  10. information reporting
  11. subsidies
  12. technical assistance

Policymakers in the United States have not relied equally upon these 12 policy instruments; some tools have been used frequently, while others remain largely experimental. Table 3-2 displays the primary policy instruments used to control air pollution, water pollution, and hazardous waste. For each of the approximately 30 pollution control programs addressed by the Clean Air Act (CAA), the Clean Water Act (CWA), and the Resource Conservation and Recovery Act (RCRA), the table displays primary instruments (marked with dark gray) as well as several auxiliary instruments (light gray) used under current law. Combinations of tools are common. Policymakers traditionally have relied most heavily on two regulatory tools that place direct pollution limits on single sources: design standards and harm-based standards. And yet, the other tools in the regulatory toolbox—while less frequently used—should not be considered unused and theoretical. Table 3-2 shows that we have turned to tradeable emissions, information reporting, and other tools for numerous programs.

Box 1-1 in chapter 1 highlights several programs over the last two decades that rely on some of the lesser used approaches, including tradeable emissions, integrated permitting, liability provisions, information reporting, subsidies, and technical assistance. Generally, familiarity and comfort level with such tools seem to be growing. For example, academics had been discussing tradeable emissions for several years before trading was incorporated into regulations in 1976. Trading became increasingly common in regulations after the 1976 offset policy, but not until the Clean Air Act Amendments of 1990 was trading incorporated into a statute. Tradeable emissions is now suggested often during the legislative debate.

A significant consideration when discussing environmental policy instruments is that the regulatory instrument Congress selects through legislation may look very different at the point its requirements are imposed on an individual source. Although statutes begin the process and influence what the source sees, they often leave a great deal of discretion to EPA, states, or localities actually implementing the requirement. For example, the Clean Water Act uses a design standard, best available technology (BAT), to describe the level of control that sources of toxic emissions must meet. EPA translates BAT into a more specific emissions limit that looks like a harm-based standard, typically specifying a numerical rate or concentration. States might incorporate the numerical limit directly into an individual permit, or negotiate with the source a compliance technology capable of meeting the numerical limit and specify that technology in the permit. Thus, in a permit, the Clean Water Act's design standard might look like a harm-based standard or technology specification.

However, the distinctions between regulatory instruments remain important. Consider the BAT example. Because BAT is a design standard, its requirements remain linked to the state of abatement technology at a particular time, and so may provide different incentives for cost-effective control or technology innovation than do other instruments. BAT might also be more dynamic, becoming more stringent as technology development makes "best" even better.

This report focuses primarily on the perspective from Congress. Nonetheless, the viewpoint from the source is also quite relevant because policy instruments are designed to affect source behavior. The report's discussion of each policy instrument seeks to reflect the fact that an instrument's ability to achieve many of society's objectives depends on both Congress' original tool selection and how the requirement is implemented.

The balance of this chapter will discuss each of these environmental policy instruments, describing each individual tool and how it is used. The chapter also highlights those criteria that may strongly affect a policymaker's choice—either because the tool is particularly effective at addressing a criterion, or raises issues that show it should be used with some caution if the criterion is important.

TOOLS WITH FIXED POLLUTION REDUCTION TARGETS

The government often uses regulation to place limitations on environmentally harmful behavior. Regulatory instruments vary in the extent to which they specify *how* a regulated entity should comply with these limitations. Technology specifications allow the regulated entity the least opportunity to select a compliance method—compliance is defined as installing a particular technology or using particular techniques. In contrast, harm-based standards describe a compliance target and regulated entities are free to choose their own method for complying with the limitation.

Policy instruments with fixed pollution reduction targets can be further divided into two groups. The first group of tools requires regulated entities[2] themselves to comply with the limitation or face associated civil and criminal penalties. Such tools are often called "traditional" or "command-and-control" approaches, because historically they are the most heavily used and are less flexible than other tools. Included in this group of single-source tools are harm-based standards, design standards, technology specifications, and product bans and limitations.

A second group of tools that also directly limit pollution focuses on multiple sources rather than single sources. Multisource tools allow a regulated entity additional flexibility in how it com-

[2] The rather awkward "regulated entity" is used interchangeably with "industry" or "firm," because this assessment is considering not only environmental regulation of the business sector but also instances in which the government itself must comply with regulatory requirements. "Facility" is used rarely because many regulatory requirements are imposed at points other than at the facility level.

TABLE 3-1: The Environmental Policy Toolbox

Tools *with* fixed pollution reduction targets	
Focus on single sources or products	
Harm-based standards	A harm-based standard prescribes the end results, not the means, of regulatory compliance. Regulated entities are responsible for meeting some regulatory target but are largely free to choose or invent the easiest or cheapest methods to comply, Sometimes referred to as health-based standards or performance standards, harm-based standards are widely used, primarily in combination with design standards.
Design standards	A design standard is a requirement expressed in terms of the state of the art of pollution abatement at some point in time, for example, "best available" or "reasonably available" technology. in a permit, design standard requirements are typically, but not always, stated as the level of emissions control the model approach is capable of achieving. Design standards written as emission limits allow individual sources the freedom to achieve the required emissions control by using the model approach or equivalent means. Design standards are very widely used, most often as part of a technology-based strategy,
Technology specifications	A technology specification is a requirement expressed in terms of specific equipment or techniques, The standard is to be met by all entities; facilities are not free to choose their means of pollution abatement or prevention. Explicit technology specifications in statutes or regulations are very rare. However, some designs standards can be considered *de facto* technology specifications when it is extremely difficult to prove to the regulatory agency that an alternative to the model technology is equivalent.
Product bans and limitations	This regulatory approach bans or restricts production, processing, distribution, use, or disposal of substances that present unacceptable risks to health or the environment, It focuses on the commodity itself rather than polluting by-products. As a result, the instrument is used most heavily under the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) and other statutes where the hazard is the commodity.
Focus on multiple sources or products	
Tradeable emissions	Emissions trading is achieved through government-issued permits that allow the owner to emit a specific quantity of pollutants over a specified period, and which can be bought from and sold to others. The government typically caps aggregate emissions from sources within a geographic region by issuing only the number of permits consistent with environmental goals. A relatively new approach to tradeable emissions is an "open market, " in which unregulated sources may opt into the program voluntarily, Emissions trading has been used most widely under the Clean Air Act and to a more limited degree to address water quality issues.
Integrated permitting	Integrated permits contain facility-wide emission limits, either for a single pollutant across multiple individual sources or media, or for several pollutants emitted to a single medium. An integrated permit might use one or several other environmental policy instruments. "Bubble" permits are used under the Clean Air Act, and to a very limited extent under the Clean Water Act. Other types of integrated permits are uncommon but are under study as part of several state pilot projects,
Challenge regulation	Challenge regulations ask target groups to change their behavior and work toward a specific environmental goal, with mandatory requirements imposed if the goal is not reached. The government identifies a goal and gives the groups time to select and implement an effective means of achieving it. Challenge regulations have the potential to be a less-intrusive way to achieve environmental goals. The concept of challenge regulation is attracting interest but is still uncommon as a stand-alone regulatory tool.

TABLE 3-1 (cont'd.): The Environmental Policy Toolbox

Tools *without* fixed pollution reduction targets	
Pollution charges	With pollution charges, a regulated entity must pay a fixed dollar amount for each unit of pollution emitted or disposed. Pollution charges do not set a limit on emissions or production. Instead, the government must calculate what level of charge will change the behavior of regulated entities enough to achieve environmental objectives. Sources are free to choose whether to emit pollution and pay the charge or pay for the installation of controls to reduce emissions. This report considers only those charges set high enough to significantly alter environmentally harmful behavior, *not* charges used primarily for raising revenues, In the United States, pollution charges have been used for solid waste control but rarely for control of other types of pollution.
Liability	Liability provisions require entities that cause environmental harm to pay those who are harmed to the extent of the damage. Liability can provide a significant motivation for behavioral change because the dollar amounts involved can be huge. This report focuses on statutory liability, *not* common law theories of liability or enforcement penalties, Several environmental statutes impose statutory liability, including CERCIA and the Oil Pollution Act.
Information reporting	Information reporting requires targeted entities to provide specified types of information to a government agency or to the public directly. Required information typically involves activities affecting environmental quality, such as emissions, product characteristics, or whether risk to the public exceeds a threshold. Information programs are widely used,
Subsidies	Subsidies are financial assistance given to entities as an incentive to change their behavior, or to help defray costs of mandatory standards. Subsidies might be provided by the government or by other parties, who thus bear part of the cost of environmentally beneficial controls or behavior. Government subsidies have historically been widely used, particularly in wastewater treatment. Subsidies from other parties are becoming more common as government budgets shrink.
Technical assistance	The government offers technical assistance to help targeted entities prevent or reduce pollution. These programs educate sources that might not be fully aware of the environmental consequences of their actions or of techniques or equipment to reduce those consequences. Technical assistance may take many forms, including manuals and guidance, training programs, and information clearinghouses. Some types of technical assistance, such as facility evaluations, are conditioned on facilities agreeing to respond with environmentally beneficial behavior. Technical assistance is very common, particularly in combination with other tools.

SOURCE: Office of Technology Assessment, 1995.

plies with emission limitations. A source can change its own behavior to fit within the limitations, or the source can make an arrangement with another entity for it to comply with the limitation on the source's behalf. This ability to transfer or negotiate responsibility among entities for changing behavior distinguishes multisource from single-source tools. Multisource tools include tradeable emissions, challenge regulation, and integrated permitting.

Harm-Based Standards

Harm-based standards prescribe the end results, not the means, of regulatory compliance. The desired end results are based on health and environmental effects of different pollution levels and patterns. With harm-based standards, regulated entities are responsible for meeting this regulatory target but are largely free to choose or invent the easiest or cheapest methods to comply.

TABLE 3-2: Primary Policy Instruments Used to Control Air Pollution, Water Pollution, and Hazardous Waste

	Tools *With* Fixed Pollution Reduction Targets							Tools *Without* Fixed Pollution Reduction Targets				
	Single-source tools				Multisource tools							
	Product bans	Technology specifications	Design standards	Harm-based standards	Integrated permitting	Tradeable emissions	Challenge regulations	Pollution charges	Liability	Information reporting	Subsidies	Technical assistance
Clean Water Act												
Point sources												
Industrial												
Existing sources												
Conventional pollutants			■	■								
Toxic/grey-area pollutants			■	■					■	■		
New sources												
Conventional pollutants			■	■								
Toxic/grey-area pollutants			■	■					■	■		
Indirect dischargers												
Existing sources												
Conventional pollutants												
Toxic/grey-area pollutants			■						■	■		
New sources												
Conventional pollutants												
Toxic/grey-area pollutants			■						■	■		
POTW's												
Conventional pollutants			■	■							■	■
Toxic/grey-area pollutants			■	■					■		■	■
Stormwater												
Industrial sources			■	■								
Municipal sources			■	■							■	
Nonpoint sources												
All sources						□					■	■
Clean Air Act												
Criteria air pollutants												
Nonattainment areas												
Stationary sources												
Existing sources			□	■	□	■						□
New sources			■	■	■	■						□

	Tools *With* Fixed Pollution Reduction Targets							Tools *Without* Fixed Pollution Reduction Targets				
	Single-source tools				Multisource tools							
	Product bans	Technology specifications	Design standards	Harm-based standards	Integrated permitting	Tradeable emissions	Challenge regulations	Pollution charges	Liability	Information reporting	Subsidies	Technical assistance
Mobile sources												
Exhaust emissions			■	□		□						
Refueling and evaporative emissions			■									
Fuel requirements	■		■			□						
Maintenance			■									
Transportation controls			■	■								
Attainment areas												
Stationary sources												
Existing sources				■								
New sources			■	□								
Mobile sources												
Exhaust emissions			■			□						
Refueling and evap. emis.			■									
Fuel requirements	■					□						
Hazardous air pollutants												
Existing sources			■	■						■		□
New sources			■	■						■		□
Acid deposition control												
Sulfur dioxide						■						
Nitrogen oxides			■									
Stratospheric ozone protection												
All sources	■					■		■				
Resource Conservation and Recovery Act												
Liquids in landfills			■							□		
Land disposal			■							□		
Land ban and predisposal tr ent			■	■						□		
Incineration			■	■						□		

■ = Primary policy instrument   □ = Auxiliary instruments

SOURCE: Office of Technology Assessment, 1995.

A harm-based standard is the most direct policy tool for implementing a risk-based strategy for achieving environmental goals. A regulatory agency typically establishes a harm-based standard by determining the amount of the pollutant in the ambient environment that will meet the health and environmental goal set by Congress. This determination involves making scientific judgments about the extent to which different concentrations of the pollutant harm human health or plants and animals the goal is intended to protect. After the agency establishes an acceptable concentration, it then uses a model to calculate an overall allowable pollution load for the region that results in this acceptable concentration. The model also must incorporate distribution and movement of the pollutant in the ambient environment, so as to avoid undesirable "hot spots."

Harm-based standards impose emission limitations on individual sources. Thus an agency apportions among individual sources what it has calculated as an acceptable pollutant concentration or loading. Some standards explicitly reserve part of the total acceptable loading for future sources, while others allocate only among existing sources. Harm-based standards might be expressed as an emission rate for the source (mass per unit time period), as a concentration of pollutant in a source's discharge, or as a percentage reduction in emissions from a source. Each of these types of harm-based standard might have short- or long-term averaging. An example of a source-specific harm-based standard is the Clean Water Act requirement that dischargers control their effluent at a level sufficient to maintain water quality standards, with emission rates expressed in a permit as tons per day and a maximum concentration.

In individual permits, emission limitations that describe a target without reference to specific technologies might in fact have originated from a harm-based standard, or might have begun as a design standard (discussed in detail in the next section).

The origin of the permit limitation is important. In contrast to harm-based standards, design standards typically start as a broad statutory term describing the level of control technology Congress expects pollution sources to implement, such as "reasonably available control technology." Such broad terms do not provide enough detail about what regulated entities must do to comply with the law. As a result, when implementing a design standard, a government agency will determine the reference technology's control capability and develop numeric emission limits based on this capability. Although they might look similar in a permit, harm-based standards and design standards are nonetheless different. For example, unlike harm-based standards, design standards can establish an implied regulatory preference for a model technology and may become stricter as new technologies are developed.

Extent of Use

Harm-based standards and design standards are the most heavily used environmental policy tools today. Typically, harm-based standards are used in combination with design standards, though occasionally harm-based standards have been used alone.

The Clean Water Act, for example, uses a combination of harm-based and design standards to attain water quality objectives. While design standards describe the baseline level of treatment to be met for all industrial discharges—a national "floor" for pollution control—the Act uses harm-based standards to place additional pollution control requirements on sources located on streams where design standards are insufficient to meet water quality goals. On these "water quality limited" streams, industrial sources must comply with a harm-based standard that calls for stricter pollution control, based on the stream quality and a level of risk identified as acceptable. Nationwide, the number of permits incorporating harm-based pollution limits is unclear; agency staff in Wisconsin and Massachusetts say they issue such permits very frequently.

The Clean Air Act also uses harm-based standards. For example, harm-based standards are used in combination with design standards for air toxics control. The Act's toxics provisions call for a design standard, maximum achievable control technology (MACT), to be used to control toxics. However, if the MACT standard is insufficient to reduce lifetime risk to the most exposed individual to less than one in a million, EPA must develop additional control requirements sufficient to meet that harm-based standard. Harm-based strategies are also used to avoid overcontrol that results in no corresponding public health or environmental benefit. Some toxics have a well-established threshold, below which human exposure is presumably safe. This known threshold might be higher than the emissions limit established by MACT. In these situations, EPA may set air toxics emission limits using the well-established threshold with an ample margin of safety, instead of requiring MACT. To date, EPA has not set such limits.

RCRA also relies in part on harm-based standards to achieve its environmental and public safety goals. For example, the statute requires that methods of land disposal for hazardous wastes are acceptable only if the proponent of the method demonstrates "to a reasonable degree that there will be *no migration* of hazardous constituents from the disposal unit or injection zone for as long as the wastes remain hazardous" (254).

Key Criteria Affecting Tool Selection

Assurance of meeting goals

Harm-based standards require that individual sources achieve a specified level of pollution abatement. As a result, they arguably are more likely to provide a higher level of assurance than instruments that do not specify a pollution control target. In addition, EPA or the administering state agency can verify compliance by reviewing monitoring data and other records, because allowable emission levels are directly linked to a single source.

However, no policy tool can ensure goals will be met unless it is properly implemented in a timely manner. Harm-based standards can be difficult and time-consuming to set because of analytical uncertainties and gaps in available data. Development of a harm-based standard is laden with uncertainties inherent in predicting the effects of different patterns and levels of environmental releases. Also, an agency needs extensive data on ambient pollutant concentrations and health effects, which often is not available. An agency that lacks necessary data has the option of setting a standard based on speculative judgments, or delaying promulgation of the standard until data gaps are filled. Both approaches would significantly impair a tool's effectiveness.

EPA has tended to delay promulgating harm-based standards until necessary health effects data become available. For example, promulgation of harm-based standards for hazardous air pollutants was extremely slow—seven in the 20 years following the enactment of the Clean Air Act of 1970. Congress shifted in 1990 to a design standard approach for controlling hazardous air pollutants. In the five years since Clean Air Act reauthorization, EPA has promulgated 10 regulations affecting 55 industrial toxic source categories and has proposed an additional 14 regulations for 16 industrial categories (5).

The harm-based standards set prior to 1990 were calculated to achieve the public health goal, while the design standards after 1990 are based on maximum achievable control technology, which may or may not achieve the goal. Yet the relative ease of implementing design standards means that *some* level of control will be in place faster than is likely under a harm-based standard. Thus, harm-based standards may have a practical disadvantage relative to design standards and other single-source technology-based tools.

Demands on government

Harm-based standards can be an administrative headache to establish, because an agency frequently lacks the necessary information about pollutants. This problem occurs most often with toxics. For example, a recent EPA report found that for the 189 air toxics listed in the 1990 Clean Air Act Amendments, 38 percent completely lacked ambient concentration data, 67 percent had little or no information on emissions sources, 31 percent lacked carcinogenicity data, and 79 percent had no validated data on thresholds for non-cancer effects (215). Collecting the data necessary to set an appropriate harm-based standard can be very resource-intensive for an agency. Congress or an agency could reduce demands on government by encouraging or requiring the targeted entities to provide necessary data. Some environmental statutes currently give EPA this authority, but it is rarely used to its fullest extent.[3]

Even when necessary data are available, setting a harm-based standard requires substantial analytical resources. Development of a harm-based standard requires an agency to determine what concentration or total loading of a pollutant will meet the legislative goal. The agency also needs to model the effects of different emission loadings, identifying the load that results in an acceptable pollution concentration throughout the target area with no undesirable hotspots. An agency must then translate the total allowable pollution load into individual source requirements. Some attribute the substantial delays in achieving the National Ambient Air Quality Standards (NAAQS) on the complexity of implementation faced by states.

Design Standards

A design standard is a requirement expressed in terms of the state of the art of pollution abatement at some point in time. A design standard might incorporate a reference point other than state-of-the-art, if the standard considers tradeoffs among effectiveness, capability, stringency, and cost. Unlike technology specifications, design standards allow individual sources the freedom to achieve the same degree of pollution control by equivalent means.

A statute prescribing design standards typically uses broad terms to describe the level of control technology it expects pollution sources to implement, such as "reasonably available control technology" or "lowest achievable emissions rate." However, such broad expressions of effectiveness do not provide enough detail about what regulated entities must do to comply with the law.[4] When implementing a design standard, EPA or the applicable state agency will determine what stringency of emission control is associated with the standard. If the design standard is, for example, reasonably available control technology, the agency first will decide whether the extent of variation within the target group justifies consideration of subgroups.[5] Then the agency identifies what entities are representative of the target group or subgroups and determines what technology is reasonably available based on those representatives. For each group or subgroup, the agency then calculates the level of emissions control that occurs when a source uses this model control technology.

Design standards are typically imposed on individual sources through permits with specific numeric or narrative emissions control requirements. These permit limits often look very similar to harm-based standards but might provide different incentives to the target entities. The limits are derived from an identified model technology or technologies, selected by the agency because they correspond to the general expression of effectiveness called for by the design standard. An entity may view that technology as the preferred one and not be as inclined to propose an alternative as it would with a harm-based standard where there is no model technology. Thus, design standards rep-

[3] For example, section 8(d) of the Toxic Substances Control Act requires that upon request a person who manufactures, processes, or distributes a chemical must submit to EPA lists and copies of health and safety studies conducted by, known to, or ascertainable by that person. The data from these studies are intended to be used in making regulatory decisions.

[4] Due process provisions in the U.S. Constitution require that requirements be detailed enough to alert a reasonable person as to what is and is not legally allowed. Requirements are unconstitutionally vague if they lack such detail.

[5] For example, EPA divided pulp-and-paper manufacturers into 25 subgroups, depending on the processes they used, when establishing design standard emission limits called for by the Clean Water Act. See 40 C.F.R. § 430.

BOX 3-1: Debates About Harm-Based Standards

Assurance of Meeting Goals

Promotes criterion: Pollution control requirements under harm-based standards are set at a level calculated to achieve a specified level of risk. Harm-based standards establish a less complex regulatory system than multi-source tools, and so are more likely to work as desired.

Impairs criterion: Data gaps and limited administrative resources often make it difficult or impossible to set harm-based standards at levels that will in fact achieve goals; in practice, standards are often set at levels hoped to be adequate, without the precise match between requirements and goals that the tool theoretically offers. Delays caused by difficulties in setting harm-based standards can mean control requirements are put in place later than they might have been under other policy tools. Because harm-based standards focus on performance, assurance depends on availability of effective emissions monitoring.

Pollution Prevention

Harm-based standards neither help nor hinder pollution prevention.

Environmental Equity and Justice

Promotes criterion: Harm-based standards respond to differences in exposure among communities. They offer communities an opportunity for input into standard-setting.

Impairs criterion: The standard-setting process is often discussed at such a technical level that nonspecialists may have difficulty participating.

Cost-Effectiveness and Fairness to Sources

Promotes criterion: Harm-based standards allow a specific source to pick a cost-effective means of compliance. They can be applied uniformly, and therefore are fair.

Impairs criterion: Because harm-based standards typically focus on individual source control, they limit a facility's ability to adopt facility-wide cost-effective measures.

Demands on Government

Impairs criterion: Harm-based standards can be administratively expensive to set, because of their substantial analytical requirements.

Adaptability

Promotes criterion: Entities are free to adopt new technologies for complying with requirements.

Impairs criterion: New scientific knowledge regarding pollution might force an agency to reevaluate and possibly adjust a harm-based standard, requiring time-consuming public notice-and-comment procedures required under the Administrative Procedures Act.

Technology Innovation and Diffusion

Promotes criterion: Harm-based standards allow sources to use innovative compliance approaches.

Impairs criterion: Harm-based standards may be relatively less effective at technology diffusion, since they do not refer to particular technologies.

SOURCE Off Ice of Technology Assessment, 1995.

resent a middle ground between technology specifications and harm-based standards with respect to the freedom a regulated entity has to expand the list of acceptable equipment or techniques.

Design standards typically are more dynamic than technology specifications. Technologies and emission limits associated with each design standard can change as the state of technology advances. Limits to be met using a "best available control technology" might become stricter as new, more effective technologies become available. Typically, an individual source receiving a new permit would need to meet these new limits at the time its emissions permit is renewed and updated.

Extent of Use

Design standards are very widely used in the Clean Air Act and Clean Water Act, and to a more limited extent in the Resource Conservation and Recovery Act. The resulting "alphabet soup" of requirements at times seems impenetrable. The degree of abatement required of a source often varies depending on whether it is 1) a new or existing source, 2) in an area that meets or fails to meet ambient standards, and 3) emitting conventional or toxic pollutants. Design standards also vary in the extent to which an agency may take economics into account when identifying the model technology and setting the corresponding emissions limitation.

The Clean Water Act uses design standards to describe the baseline level of treatment to be met for all discharges—in effect, a national floor for pollution control.[6] EPA sets a design standard for each relevant industry category based on representative facilities within the category. These standards are to be updated by EPA every five years. Existing sources must use best conventional technology (BCT) to control conventional pollutants.[7] Existing sources of nonconventional[8] and toxic pollutants are required to use best available technology economically achievable (BAT). EPA will determine when setting BCT whether the relationship between control costs and water quality benefits is "reasonable,"[9] while the agency need only determine that BAT is "economically achievable."

New sources of any type of water pollutant must meet best available demonstrated control technology (BADCT), also called new source performance standards (NSPS). NSPS pollution limits can be based on available demonstrated technologies, but also upon alternative production processes, operating methods, in-plant control procedures, and other alternatives to an "end-of-the-pipe" focus. EPA need only "consider cost" when setting NSPS. No cost-reasonableness consideration is required. As a result, new sources subject to NSPS almost always must meet a stricter level of emissions control than existing sources. In exchange, the Clean Water Act provides that such sources are exempt for 10 years from additional design standard requirements for nontoxic pollution.[10]

Where BCT, BAT, or NSPS design standards are not sufficient to meet water quality goals on a particular stream, the Clean Water Act calls for a stricter harm-based standard set at a level sufficient to meet water quality goals.

[6] More stringent treatment may be required if necessary to achieve water quality standards, or if the state chooses to implement a more stringent program than the national baseline requirements.

[7] These include fecal coliform, pH, total suspended solids, biochemical oxygen demand (BOD), and oil and grease.

[8] Nonconventional pollutants are also called "gray area" pollutants and include nitrogen, nitrates, phosphorus, chlorine, fluoride, some metals, and some pesticides.

[9] EPA adopted a two-part approach to this "cost-reasonableness" test. First, costs should be roughly similar to those imposed on publicly owned treatment works (POTWs). Second, costs should be analyzed in light of resulting water quality benefit. EPA's first effort at developing BCT regulations was reversed because the Agency did not sufficiently consider cost-effectiveness.

[10] The exemption is for 10 years, or until the facility is fully depreciated, whichever occurs first. Clean Water Act §306(d).

The Clean Air Act and implementing agencies rely heavily on design standards to meet ambient air quality goals. Existing major sources must meet reasonably available control technology (RACT) in areas that fail to meet ambient air quality standards. RACT acts as a national minimum level of control in nonattainment areas and is usually defined as the lowest emissions limitation that a source is capable of meeting by using a control technology that is reasonably available, considering technological and economic feasibility. In contrast, *new* sources in these "nonattainment" areas must adopt control technologies that achieve the lowest achievable emissions rate (LAER). LAER is often much stricter than RACT. LAER is to be based on the most stringent emissions limitation contained in any state implementation plan or achieved in practice by the same or similar source category, whichever is more stringent.

Sources in areas that already meet ambient air quality goals are subject to design standards under the Clean Air Act. For example, new sources in areas that meet ambient standards must install best available control technology (BACT), often a stricter level of control than required under RACT but less than LAER.

Sources of air toxics must meet an emissions limit comparable to that resulting from use of the maximum achievable control technology. MACT is based on the best technology currently available for the source category in question and must be at least as stringent as the level achieved in practice by the best controlled source in the source category (for new sources), or for the best performing group of sources (for existing sources).

RCRA also incorporates some design standards in its waste management requirements. For example, EPA uses best demonstrated available technology (BDAT) to describe the class of treatment technologies that must be used before a hazardous waste may be disposed on land. The Agency developed a BDAT treatment requirement for each group of wastes with similar physical and chemical properties and sought to base the requirements on technologies that furthered waste minimization and recycling.[11]

Key Criteria Affecting Tool Selection

Assurance of meeting goals

Design standards require a specified level of pollution control from each individual regulated entity. As such, design standards help ensure that *pollution reduction* goals are met, but cannot guarantee that *environmental quality* goals will be met. Design standards are less analytically complex and data intensive than harm-based standards and typically have been implemented at a faster rate. Their relative ease of implementation means that *some* level of control will be in place faster than is likely under harm-based standards. Similarly, some authors have argued that this form of regulatory system is less complex and therefore has a greater chance of success than market-based approaches (95).

Critics of design standards point out, however, that design standards very indirectly assure attainment of a risk-based goal. In places that do not currently meet environmental goals, design standards move things in the right direction by ensuring that those polluters that have not yet installed the required level of technology do so or adopt an alternative strategy that meets required emission limitations. This general movement will not necessarily ensure that a risk goal is achieved. First, existing technologies may not be capable of reducing discharges from a single source to the level necessary to achieve pollutant concentrations in the receiving media that meet the risk goals.

Second, even if a single plant's compliance with a design standard is capable of meeting the goal, the design standard approach does not prevent neighboring sources from discharging the

[11] EPA may select a technology that furthers waste minimization and recycling over more conventional treatment if the disparity in performance of the technologies is not too pronounced, and the technology selected minimizes threats to human health and the environment by substantially diminishing waste toxicity and reducing mobility of toxic constituents. 55 FR 22520, 22535 (June 1, 1990)(Third-Third final rule).

same pollutant. The cumulative effect of discharges from two or more facilities, all of which meet prescribed design standards, can be a concentration of pollutants that violates the risk-based goal. This characteristic weakness of a design standard is often shored up by combining it with a harm-based standard that takes effect if the design standard fails to attain the goal.

Pollution prevention

The effect of design standards on pollution prevention is ambiguous. Design standards typically are based on an end-of-the-pipe approach, and sources have an incentive to adopt the model technology that is familiar to the regulatory agency. However, design standards do offer an opportunity for a regulated entity to propose an alternative to the model technology or approach. Thus, if "moving up the pipe" and preventing pollution appears to be the least expensive way of achieving compliance, sources are free to do so.

A design standard can either promote or discourage the use of pollution prevention, depending on what approach was considered the model for calculating emissions. If the standard is based on an end-of-the-pipe technological solution, the instrument could act as a disincentive for pollution prevention. However, a design standard could base emission limits on particular pollution prevention measures, thereby encouraging pollution prevention. In practice, even when EPA wishes to establish a preference for pollution prevention, the signals might be mixed. For example, EPA prefers to base BDAT requirements for treating hazardous wastes on technologies that further the statutory goals of waste minimization and recycling.[12] Some pollution prevention specialists suspect the BDAT focus on technologies for minimizing waste fails to create a preference for preventing pollution in the first place.

Demands on government

Agency resources required to establish and revise a design standard are likely to vary, depending on how much is known regarding the targeted industry and its processes and pollutants. An agency would need to delineate appropriate target groups and subgroups, identify the appropriate model technology or strategy—"best," "conventional," "reasonable," or whatever the statute called for—and determine the emissions control levels associated with that technology or strategy. As with all regulatory approaches, an agency must be prepared to justify its determinations, both in court and to oversight agencies such as the Office of Management and Budget.

These analytical and data requirements typically are less than for a harm-based standard. EPA has found it easier to delineate appropriate target groups and model technologies than to determine the appropriate level of a harm-based standard. Data on facility characteristics, wastestreams, and plant processes are more readily available than pollutant effects data. Also, identifying the relevant "best," "reasonable," or other legislatively mandated model technology typically is easier than determining a "safe" level for a pollutant.

Again, the air toxics program under the Clean Air Act shows that design standards are easier for an agency to implement than harm-based standards. In the five years since the air toxics program has been based on a design standard, EPA has promulgated 10 regulations affecting 55 industrial toxic source categories and has proposed an additional 14 regulations for 16 industrial categories (5). During the previous 20 years, when a harm-based standard applied, EPA was able to issue only seven standards.

It is important to note that design standards still require significant agency resources to set and implement, even though they are more manageable

[12] EPA may select this type of technology as BDAT over more conventional treatment if the disparity in performance of the technologies is not too pronounced, and the technology selected minimizes threats to human health and the environment by substantially diminishing waste toxicity and reducing mobility of toxic constituents. 55 FR 22520, 22536 (June 1, 1990).

than harm-based standards. EPA recently estimated that it "traditionally takes about four years to develop national technology-based standards such as [air toxics] standards" (216). EPA recently proposed a streamlined approach to setting MACT control levels for air toxics to help reduce resources needed to set design standards.

Adaptability

A design standard accommodates technological development, but on a limited scale. If an agency decides to adopt a new technology as a replacement model technology, it must recalculate the corresponding emissions limitation. Such reformulation might occur if a new control technology becomes more effective or an existing one significantly less expensive. For example, under the Clean Water Act, EPA is required to review its design standards at least every five years and revise if appropriate (243). Revision would be subject to public notice and comment procedures, as required under the Administrative Procedures Act.

Technology Specifications

A technology specification is a requirement expressed in terms of specific equipment or techniques. The requirement is to be met individually by all regulated entities. Facilities are not free to choose their means of pollution abatement or prevention. Compliance focuses on whether or not the specified approach is in place and operating according to specifications—regardless of whether the approach is a particular control technology or a series of actions or techniques. Compliance does not depend on meeting a specified ambient environmental quality.[13]

At the permit level, technology specifications are expressed as a technology required in order to be in compliance with a permit, while harm-based standards and design standards would be represented by a numerical limit. Design standards provide greater freedom for a regulated entity to expand the list of acceptable compliance equipment or techniques. Harm-based standards leave regulated entities free to select their own compliance approach.

Differences between technology specifications and design standards are sometimes confusing and misunderstood. One source of confusion is the important distinction between a technology specification and "technology based." A technology specification actually requires regulated entities to use the stated technology, while "technology based" simply indicates the origin of the emissions limitation without requiring the model technology used to set the limitation. Many design standards are technology based.[14]

A second source of confusion is caused by *de facto* technology specifications. De facto technology specifications might exist in at least three circumstances. First, a de facto technology specification is created when the legislature or regulatory agency setting up a design standard fails to describe what parameters of a proposed technology must be "equivalent" to the model technology. This results in regulated entities' having no practical way to demonstrate equivalency of any alternatives to the model technology. Defacto technology specifications also might occur when only one technology is available to meet the standard even though it is not specified, or when an entity decides the technology used to develop a design standard is the safest and quickest compliance approach. Note, however, that in each of these circumstances firms still have flexibility to develop a new technology or to propose a technology different from that used to develop an emissions level.

[13] As a result, discharge or ambient monitoring is not necessary under a "pure" technology specification, unless necessary to determine the technology is being operated according to specifications.

[14] "Technology based" essentially indicates use of an abatement-based strategy and does not specify an instrument per se. For example, the emission limits imposed through tradeable permits or integrated permitting could be technology based.

BOX 3-2: Debates About Design Standards

Assurance of Meeting Goals

Promotes criterion: Design standards establish a less complex regulatory system than multi-source tools, and so are more likely to work as desired. They allow an agency to determine compliance by monitoring whether the model technology is used, rather than monitoring emissions directly.

Impairs criterion: Pollution control levels achievable by identified model technologies may not be stringent enough to achieve environmental goals. Design standards do not address cumulative effects of discharges from multiple sources.

Pollution Prevention

Promotes criterion: Design standards can create a preference for pollution prevention, if desired.

Impairs criterion: Design standards can inhibit pollution prevention efforts, if the agency picks an end-of-the-pipe technology as its model technology.

Environmental Equity and Justice

Promotes criterion; Design standards offer communities input into the standard-setting process.

Impairs criterion: Design standards do not address "hot spots, " or differential impacts on communities.

Cost-Effectiveness and Fairness to Sources

Promotes criterion: Entities are free to propose an equivalent, more cost-effective pollution control approach. Design standards are fair because they impose similar requirements on similar facilities.

Impairs criterion: Design standards may not be cost effective because they do not consider differences in cost across facilities. They can be unfair because they often differ across industries.

Demands on Government

Promotes criterion: Analytical requirements for setting design standards are less demanding than harm-based standards.

Impairs criterion: Design standards still require substantial analytical and data resources.

Adaptability

Promotes criterion: Entities are free to propose a new technology, if equivalent to the model technology.

Impairs criterion: If an agency adopts a new technology as the model technology, it must recalculate the corresponding emission limitations. Design standards are subject to time-consuming public notice-and-comment procedures required under the Administrative Procedures Act.

Technology Innovation and Diffusion

Promotes criterion: Design standards encourage suppliers of pollution control equipment to innovate, because the new technology might become the "model" technology and have an immediate market. Design standards promote diffusion of the "model" technology.

Impairs criterion: Regulated entities may use the existing model technology instead of innovating, because of the expense of proving a new approach is "equivalent." Regulated entities may feel disinclined to develop more effective control technology because it might cause tighter emission limits.

SOURCE. Off Ice of Technology Assessment, 1995.

Extent of Use

Explicit technology specifications appear to be rare. OTA was unable to identify any examples of their use to solve environmental problems.

The rarity might be explained by a reluctance of legislators and regulators to create a technological straightjacket on entities, which in most situations would not allow for technological improvements now or in the future. Some commenters argue that technology specifications might be desirable where the need for environmental control is strong and immediate, where a demonstrated compliance technology is at hand, and where administrative ease and enforceability are principal concerns. The instrument might also be useful where a small number of sources, or a single source, are responsible for an environmental problem.

De facto technology specifications exist, but data is lacking on how often they occur. Industry representatives assert they are far more common than necessary. Many critics of the current environmental regulatory structure assert that requirements are often de facto technology specifications, even if expressed using other instruments.

Key Criteria Affecting Tool Selection

Assurance of meeting goals

Defacto technology specifications offer a higher level of assurance than many other regulatory instruments because of their ease of enforcement. An inspector would need only to determine that the specified technology or technique is in place and operated appropriately. However, like design standards, technology specifications can only ensure that environmental quality goals are met if the standard is set appropriately.

Establishing a technology specification as part of a technology-based strategy would be analytically similar to design standards. Use of technology specifications for risk-based strategies offers a greater opportunity for a mistake, because the agency needs to identify the technology or techniques associated with a particular level of emissions.

Pollution prevention

A technology specification can either emphatically promote or discourage the use of pollution prevention, depending on what approach has been specified. If the requirement calls for an end-of-the-pipe technological solution, the instrument is a strong disincentive for pollution prevention. However, if the requirement specifies particular pollution prevention measures that must be taken in order to be in compliance, the instrument strongly encourages pollution prevention.

Cost-effectiveness and fairness

Technology specifications, in theory, are unlikely to achieve a cost-effective level of pollution control. They do not allow entities to substitute for the specified technology or approach a cheaper or more effective way to control emissions. Economic theory predicts that this lack of flexibility will inhibit achievement of a cost-effective control solution.

A technology specification might be viewed as fair because it imposes a uniform requirement on all entities. However, the application of such standards in an arena where entities have been previously regulated, or in other ways differ considerably, might achieve unfair results.

Adaptability

Technology specifications define compliance as using a specific technology. Rulemaking is required, therefore, if someone wants the standard to adapt to changing circumstances. Because explicit technology specifications are rarely if ever used, their adaptability to change is purely theoretical. De facto technology specifications are more commonly used, but data on their adaptability are limited and largely anecdotal.

Development of new control technologies does not require a technology specification to be changed, unless additional reasons for change exist. An agency could in theory continue to require the preexisting technology. However, the agency might conclude it must reformulate the technology specification if cost or control efficiencies of the new technology make it unreasonable to continue to require the old technology.

Similar to design standards, new scientific information might encourage reformulation of a technology specification if new information indicates underlying goals are unmet by the existing standard, but would not require it.

Product Bans and Limitations

This regulatory instrument bans or restricts manufacture, distribution, use, or disposal of substances that present unreasonable risks to health or the environment. Product bans and limitations focus on the commodity itself rather than on polluting byproducts from its manufacturing. As a result, they are used primarily where the hazard is the commodity.

Some products that provide societal benefits also cause environmental harm. Asbestos is a nonflammable substance used as heat and sound insulation in buildings and many products. The benefits of pesticides and other economic poisons have done much to prevent crop infestations, choking weeds, noxious animals, and disease. At the same time, however, there has been a growing awareness that these benefits are not without hazards, and that the products may be harmful to humans and the balance of nature. Product bans and limitations typically seek to balance benefits and costs of these products. A product ban may be appropriate where product use is intrinsically sufficiently damaging that zero use is a desirable outcome.

Product bans and limitations may be imposed prior to the product's sale and use in commerce, or after the product has been used and its harmful effects are observed. Premarket product approval systems seek to prevent excessively risky products from reaching the marketplace at all. Under product approval systems, a government regulatory agency reviews the effects of the new product before it is marketed, ultimately approving it or disapproving it for commercial introduction or placing limitations on its use that are designed to bring product risks to an acceptable level. The burden of producing information and of persuading regulators of product safety usually rests with the proponent of the new product.

Extent of Use

Because some products that provide societal benefits also cause environmental harm, Congress has enacted statutes empowering regulatory agencies to halt or otherwise restrict the manufacture, distribution, and use of such products (165). The policy approach has been used under the Clean Air Act and more widely adopted in other statutes for control of pesticides and chemicals.

The Clean Air Act Amendments of 1990 addressed the problem of stratospheric ozone depletion by establishing a program that gradually introduced a ban on use of ozone- depleting substances (240). The statute established initial lists of substances that were to be phased out, grouped as Class I[15] and Class II substances.[16] EPA is directed to list additional substances as necessary. The statute begins reducing allowable production of these substances in 1991 and imposes outright bans a number of years later. For example, production of Class I substances begins to phase out in 1991, and as of 2000 production of all Class I substances is prohibited.[17] Class II substances are prohibited after 2030.

The chlorofluorocarbons (CFC) phaseout and ban is an illustration of how policy instruments might be combined to limit undesirable effects. During the phase-in period of the ban, the statute establishes a pollution charge based on tonnage produced and weighted by the harmfulness of each chemical. In addition, the statute directs EPA to establish transferable "allowances" for the production and use of the Class I and II substances.

[15] Class I substances include chlorofluorocarbons, halons, carbon tetrachloride, and methyl chloroform.

[16] Class II substances include hydrochlorofluorocarbons.

[17] The ban on methyl chloroform takes effect in 2002.

BOX 3-3: Debates About Technology Specifications

Assurance of Meeting Goals

Promotes criterion: Technology specifications are relatively easy to administer and monitor, and so are less likely to fail than other tools.

Impairs criterion: The specified technology may not be adequate to meet goals.

Pollution Prevention

Promotes criterion: A technology specification can promote pollution prevention if it specifies pollution prevention measures.

Impairs criterion: A technology specification that specifies an end-of-the-pipe technology approach discourages pollution prevention,

Environmental Equity and Justice

Promotes criterion: Technology specifications are fair because they impose uniform requirements on all entities.

Impairs criterion: The lack of flexibility available under a technology specification makes cost-effective pollution abatement unlikely. Technology specifications can be unfair because they do not take into account differences among entities' prior control behavior or equipment.

Cost-Effectiveness and Fairness to Sources

Promotes criterion: Monitoring compliance with technology specifications is relatively easy.

Impairs criterion: Technology specifications limit choice and thus can be expensive,

Demands on Government

Promotes criterion: Monitoring compliance with technology specifications is relatively easy.

Impairs criterion: Technology specifications can be administratively difficult to establish because of the need to identify a technology that can achieve goals.

Adaptability

Promotes criterion: Development of new technologies does not require the agency to change a technology specification, unless the new technology clearly is superior.

Impairs criterion: A new or altered technology specification would be subject to time-consuming public notice-and-comment procedures required under the Administrative Procedures Act.

Technology Innovation and Diffusion

Promotes criterion: Technology specifications cause wide dissemination of the specified environmentally beneficial technology or approach.

Impairs criterion: Technology specifications discourage innovation in pollution control and prevention.

SOURCE: Office of Technology Assessment, 1995

Presumably the pollution charge is intended to encourage more rapid shift from use of CFCs, and trading is provided to soften the economic impacts of a ban. The phase-in of the ban has occurred more rapidly than expected. For example, by the end of 1992, CFC production was less than 50 percent of 1986 production levels, when those levels were viewed as very difficult to achieve prior to 1999 (193).

A ban was used to address the adverse health effects from airborne lead emitted by gasoline-powered automobiles. The lead ban was implemented gradually over several years. EPA began lowering the allowable lead in gasoline as early as 1973, although the phaseout of leaded gasoline began in earnest in 1985. EPA established a limit of 1.1 grams per gallon for the content of leaded gasoline beginning in July 1985 and 0.1 grams per gallon after January 1, 1986 (265,266). This aggressive phase-down schedule was combined with an EPA program allowing trading in lead credits among refiners. The Clean Air Act Amendments of 1990 prohibit the use of any gasoline which contains lead or lead additives after 1995 (238).

Key Criteria Affecting Tool Selection

Assurance of meeting goals

Product bans or limitations can be an effective way of achieving risk-based goals for the immediate consumers of the product. If the product poses unacceptable risks to consumers, the agency can prohibit its sale, distribution, and use and thereby eliminate those risks. Or, an agency can place limitations on the sale, distribution, and use of the product sufficient to reduce those risks to acceptable levels.

The degree of assurance provided by a product ban or limitation depends on availability—now or in the near future—of safer alternative products. An agency cannot be certain that substitute products will not have their own environmental problems. For example, the ban on lead paint has led to use of alternative rust-inhibiting coatings for steel that may involve other metals, such as chromium, that can have deleterious effects on human health.

Product bans or limitations historically have been used "when the cows are already out of the barn"—after the products are well-distributed through commerce and already causing environmental problems. Banning or limiting polychlorinated biphenyls (PCBs) in transformers does little to reduce the risk posed by the PCBs that have already drained from discarded transformers. In such cases, abatement programs are necessary to address risks posed by past use of products. An example is the asbestos abatement program that Congress established for schools (203).

Pollution prevention

Product bans and limitations can lead to pollution prevention, by preventing products with adverse environmental effects from being manufactured and used.

Cost-effectiveness and fairness

No empirical data, and almost no technical economic literature, explores the cost-effectiveness of product bans and limitations as a tool to reach human health and environmental goals.

Theory would imply that, to be cost-effective, the ban or limitation must be well-tailored to the situation. A ban is best used where all uses of a product pose unacceptable risks. A ban might be overly broad if some product uses did not pose those risks, suggesting that product limitations might be more appropriate in those circumstances. For example, a complete ban on lead paint as a means to protect children from ingesting lead-laden paint chips might be overly broad if there are uses extremely unlikely to give children access to the lead paint, such as shipboard and other outdoor uses of red lead as a rust inhibitor. A selective ban or product use limitation might achieve the objective of preventing children's exposure to lead. An agency rarely has the analytical resources to set up such a cost-effective ban or the enforcement resources to prevent unauthorized uses.

Adaptability

Product bans or limitations require time-consuming proceedings if scientific developments or new political priorities indicate that more or less regulation is appropriate. Rulemaking procedures would be necessary if the constraint were imposed by regulation. If the constraint were imposed by legislation, such as the CFC ban in the Clean Air Act, Congressional action would be required for significant programmatic change.

Technology innovation and diffusion

In markets in which no substitutes are available, the product ban or limitation has the potential to induce technological innovation by stimulating rapid research aimed at products that are capable of filling the void left by the limited ban or product. This form of "radical technology forcing" takes a leap of faith on the part of the regulatory agency. For example, when EPA initiated cancellation proceedings against the pesticide mirex, its manufacturer argued that the southeastern United States would be left defenseless against imported fire ants, because the only registered substitute for mirex was a pesticide that was also the subject of an EPA notice to cancel. In phasing out mirex use, EPA assumed that other companies would develop new alternative fire ant killers to replace mirex. Four substitutes did in fact become available before the end of the phaseout period (117).

The fact that a product ban results in rapid development of alternatives in one context, however, does not necessarily guarantee that a similar result will occur in all contexts. Banning a proposed product or technology at the pre-marketing approval stage could result in deeper entrenchment of an old product or technology. Using bans or limitations to induce innovation may not work as well for environmental problems with complex causes, and may be too risky to employ in contexts in which the consequences of the failure to inspire technological innovation are very high. The approach seems best suited for the converse situation in which the risks of doing nothing are high.

Integrated Permitting

Environmental laws make extensive use of permits. Permits make individual sources[18] subject to general statutory requirements. In many instances, entities may not legally emit pollutants other than in compliance with a permit. Monitoring and reporting requirements often are imposed through permits. Pollution control or other requirements might be expressed using a variety of different policy instruments, including technology specifications, harm-based standards, tradeable emissions, and other instruments discussed in this assessment.

Concern about multimedia effects and potential burdens of the permitting process has led EPA and many state agencies to consider making changes in the way permits are issued. Often called "consolidated permitting," these permitting approaches can be divided into two groups based on their principal purposes: 1) streamlined permitting, and 2) integrated permitting.

Streamlined permitting is used by many agencies to make the administrative process less burdensome by providing permit coordinators, "one-stop permit shopping," and similar measures to lessen time delays and paperwork. With integrated permitting—far less common of the two—the government considers comprehensive environmental impacts when making decisions regarding emission limits for an individual permit.

Integrated permitting can take two approaches: 1) single medium, and 2) facility-wide cross-media. Agencies have used integrated permits to combine all sources of pollution to a particular medium, rather than having a permit for each individual emissions point at a facility. A facility-wide permit might list emission limits for each source within the facility. Or, a facility-wide permit might list a single limit per pollutant for the

[18] The definition of "source" varies from regulation to regulation. It may connote an entire facility, or a single pipe or smokestack.

BOX 3-4: Debates About Product Bans and Limitations

Assurance of Meeting Goals

Promotes criterion: Product bans or limitations remove excessively risky products from the market, or prohibit use of the product in risky situations. They can be implemented very quickly, in a perceived emergency.

Impairs criterion: There is no guarantee that a less risky product will be developed as a substitute.

Pollution Prevention

Promotes *criterion:* Bans or limitations can in effect require pollution prevention, by preventing products with adverse environmental effects from being manufactured and used.

Environmental Equity and Justice

Promotes criterion: Bans and limitations place constraints on the distribution and use of excessively risky products, that apply uniformly among communities.

Impairs criterion: Product bans and limitations do little to remediate problems created by prior use of risky products.

Cost-Effectiveness and Fairness to Sources

Promotes criterion: Product bans or limitations are fair, when applied uniformly.

Impairs criterion: Bans and limitations can be expensive if applied more broadly than the risk posed. Pre-manufacturing review is unfair, since it subjects new products to stricter standards than existing products (which are re-reviewed only sporadically).

Demands on Government

Impairs criterion: Administrative resources to analyze data in support of a product ban or limitation can be very large, because of the draconian nature of the tool. This approach requires a credible enforcement presence to be effective, which in the case of tailored bans or limitations will need significant administrative resources.

Adaptability

Impairs criterion: An altered product ban or limitation would be subject to time-consuming public notice-and-comment procedures required under the Administrative Procedures Act.

Technology Innovation and Diffusion

Promotes criterion: Product bans and limitations can spur rapid innovation, by highlighting a market in need of substitutes for the affected product.

Impairs criterion: Banning or limiting a product at the pre-market stage can further entrench existing products.

SOURCE. Office of Technology Assessment, 1995.

entire facility, creating a bubble-like performance standard that requires the facility to meet an overall emissions cap through any combination of controls. Unlike EPA's current Bubble Policy, which effectively freezes an initial reallocation of control responsibilities among sources (267), an integrated permit might allow flexibility to alter on an ongoing basis the mix of control levels for sources within a facility.

Another form of integrated permitting combines limitations on emissions to air, water, and land in a single permit, taking into account the potential at a facility for pollution to move between media. This multimedia type of integrated permitting may allow an agency to trade off reliance among policy approaches, if emission limits in the different media use different instruments.

Table 3-3 illustrates the wide variety of integrated and streamlined permitting approaches that have been described as elements of "consolidated permitting." Many permit reforms focus on lowering administrative burden for the regulatory agency and the permit applicant. Other permit reform efforts seek to improve both the administrative burden and adequacy and cost-effectiveness of environmental protection. This OTA assessment is focusing primarily on programs that pursue both goals.

The strengths and weaknesses of integrated permitting will depend in part on the specific design and implementation of the permit program, and in part on the instruments used to express the requirements the permits impose. As a result, integrated permits as a regulatory tool should always be considered from the perspective of the other instruments they incorporate.

Extent of Use

Integrated permitting has been used only on a limited scale, although it is not a new idea. In 1980, EPA consolidated permit procedures for several programs under the Clean Air Act, the Clean Water Act, the Resource Conservation and Recovery Act, and the Safe Drinking Water Act. The rule focused on streamlining measures, such as use of a single general permit application form, but also sought a "more comprehensive management and control" of pollution through "consolidation of permit requirements and processing procedures. . ." (262). This more integrated approach to permitting was fiercely resisted in some quarters, and the Agency abandoned the effort in the mid 1980s as part of its regulatory relief activities. In the Federal Register notice that repealed the consolidated permitting rule, EPA noted "[t]he fact that the various permit programs regulate inherently different activities and thus must impose generally different sorts of requirements has limited commonalties across permit programs" (264). The Agency felt that consolidated processing of multiple permits had been very rare.

Integrated permitting once again is receiving growing attention from states and EPA. Some states recently have begun to experiment with integrated permitting. For example, the 1991 New Jersey Pollution Prevention Act establishes requirements for pollution prevention plans, and sets up a pilot program to integrate a wide array of environmental permits and approvals into a single permit. The legislation authorized up to 15 participants. As discussed in chapter 2, the state issued its first cross-media integrated permit in late 1994, to a pharmaceutical firm, and two other permits are in the final development stage.

New York has attempted to integrate some of its permitting activities for large industrial facilities, by setting up a 12-person permit team to examine cross-media transfers and explore pollution prevention opportunities. The Minnesota Pollution Control Agency has established a voluntary flexible permit program, that offers firms the option of obtaining a single, integrated facility-wide permit for all of its sources for a particular emission or for various emissions. The program is in early stages; the only integrated permit issued thus far is for a 3M tape manufacturing plant that emits volatile organic compounds (VOCs) into the air. The permit allows 3M to shift emission controls among the sources within its facility, so long as the aggregate VOC control levels are satisfied.

TABLE 3-3: The Varied Approaches To "Consolidated Permitting"

Permitting type	Permitting approach	Key element(s)	Example jurisdictions
Integrated	Multi-Media Permitting	Single permit incorporates all emissions from a facility to air, water, and land.	New Jersey (pilot)
Integrated	Facility-wide "bubble"	Single permit sets an aggregate emissions limit to one medium for the entire facility, allowing the facility to shift control responsibilities among individual sources at the facility.	Minnesota (pilot)
Integrated	Facility-wide permit specifying limits for each source.	Single permit incorporates emissions to one medium from every source at the facility, specifying a limit for each source.	Permits under EPA's "Bubble Policy"
Streamlined	One-Stop Permitting	Single office or person has final authority for all relevant permits.	Georgia, Kentucky, South Dakota
Streamlined	Permit Assistance Offices	Office or liaison available to provide information re: requirements, assist during permit process,	Indiana, California, Michigan, New York
Streamlined	Permit Coordinator	Single office or person has formal duty to coordinate specific project proposals. Have less authority than under one-stop system.	Michigan, Tennessee, Michigan
Streamlined	Permit Deadlines	Fixed deadlines for permit issuance or denial, often 60-90 days. Frequently, automatic permit issuance if deadline missed by agency.	Maine, Montana, North Carolina, New Jersey (common, roughly half the states have permit deadlines)
Streamlined	Permit Information	Efforts to coordinate information from various programs for prospective permit applicants, usually as guidebooks or brochures	California, New York (very common; virtually every state)

SOURCE Off Ice of Technology Assessment, 1995

Key Criteria Affecting Tool Selection

Assurance of meeting goals

Proponents of integrated permits argue that multimedia permits are necessary because present regulatory efforts to control pollutants in one environmental medium can result in merely transferring the pollutant to other environmental media (56,131). Others are skeptical that significant amounts of pollutants go unregulated. They note that with today's extensive environmental statutory structure, it is much more difficult for emissions to slip through the regulatory cracks (169).

Determining whether or not pollutants do indeed become unregulated by crossing environmental media is beyond the scope of this assessment. However, the extent of the cross-media problem has a strong effect on the degree to which integrated permits would improve assurance that environmental goals are met.

One common criticism of multimedia integrated permitting is the analytical complexity of modeling cross-media emissions and risks. The fear is that integrated permitting may create an elaborate shellgame that obscures pollution emissions that could have been more effectively regulated under traditional permitting. Ideally, accurate and adequate data would be available to weigh all facility inputs and outputs and consider all possible cross-media transfers. A 1990 EPA report on data requirements for integrated permitting found such data were lacking (80,149).

Integrated permits addressing releases to a single environmental medium are likely to require less sophisticated analysis. For single-medium integrated permits that establish fixed limits for each source, assurance is likely to be the same as the instrument used to express the requirement. For those single-medium permits that establish a plant-wide bubble, monitoring must be sufficient to track emissions of the pollutant from all sources. Lack of monitoring capability can discourage use of flexible plant-wide bubbles. For example, during early development of EPA's Bubble Policy, staff were concerned that monitoring capabilities were not sophisticated enough to track movement of emissions between multiple sources within a single facility (94). As a result, permits under the Bubble Policy specify limits for each source (267).

Minnesota has recently adopted an integrated air permit program that requires facilities to propose a method to ensure continuous compliance with each facility-wide emissions limit through monitoring or an equivalent tracking system (149). While an integrated permit need not be conditioned on continuous monitoring, the Minnesota program illustrates an approach designed to increase assurance environmental goals will be met.

Cost-effectiveness and fairness

Limited data is available on control cost savings from integrated permitting. Integrated permit programs with a single aggregate emissions limit for an entire facility would allow significant process and emissions flexibility which, in theory, a firm could use to help find a more cost-effective means to comply with requirements. Integrated permits issued under EPA's Bubble Policy include specific limits for each individual source within a facility and do not allow limits to "float" among sources. As of 1986, $132 million in reported cost savings were achieved by 20 firms through bubbles (72).

This flexibility can make integrated permits attractive to regulated entities. For example, one of the principal reasons 3M sought an integrated permit in Minnesota was to have the flexibility to change the mix of source controls used to meet requirements for VOC emissions control, without time-consuming agency approvals (149). Some forms of integrated permits include limits to all sources in one permit, but do not allow the facility to shift control responsibilities between sources. With this form of permit, control cost savings are strongly affected by the regulatory instruments incorporated into the permit and the terms of the permit itself.

Demands on government

A major issue with integrated permitting is the government administrative resources required to issue permits. Proponents say that integrated permitting can achieve administrative cost savings for both the regulatory agency and the permit holder, due to fewer permits and a less fragmented process. Others note that administrative costs might increase, because an integrated permit is typically much more complicated than a conventional permit and takes longer to evaluate. Experience to date is very limited but shows signs that to some degree each of these views might be correct, depending on whether the short-run or long-run timeframe is considered.

Some states have estimated that in its early stages an integrated permitting program can require substantial resources and delay. For example, the schedule for completing the first pilot multimedia permit in New Jersey allowed 12 to 24 months for input and review by both agency and applicant (149). The time period for issuing a conventional permit varies from around five months for a routine emissions permit under the Clean Water Act, six to 12 months for air permits, to up to three years for an interim RCRA permit and much longer for a final RCRA permit.

Whether these administrative costs of processing the integrated permit are greater than the aggregate costs of the multiple permits it is replacing is uncertain; the New Jersey permit was for a facility that previously had 897 permits just for air quality.[19] Minnesota similarly found that negotiating its first facility-wide permit was resource intensive. "We had to devote multiples of our normal resources for such a project," explained one official. "It involved more people, more research, more drafts, more visitation of site, and more everything" (149).

However, the long-term effect of integrated permitting on administrative burden is unclear. Both New Jersey and Minnesota state agencies attribute these extensive resource needs to the novelty of the integration process rather than a fundamental characteristic of integrated permits should they be used more widely. They felt that efficiencies are likely to increase (149). In addition, existing integrated permit programs seem also to incorporate elements of streamlined permitting, such as one-stop permitting and a permit coordinator. If included in the permit program, such provisions have the potential to cut down on duplicative effort and time delays.

Tradeable Emissions

Under tradeable emissions, the government first sets a level of aggregate emissions over a specified time period, consistent with environmental goals by issuing only the number of permits corresponding to that level. The total allowable emissions are then allocated to individual sources through government-issued permits. Unlike under conventional permit systems, however, each regulated entity can buy and sell permits from others. The entity might choose to do so if the relative costs of emissions control make it less expensive to buy (or profitable to sell) the permit to another entity. In theory, trading would continue until the cost of controlling yet another pound of pollution is the same for all entities and is equal to the cost of a permit. In practice, other factors strongly affect the amount and results of trading.

Not all trading systems are alike. For example, the level of government involvement in trading can be an important determinant of potential benefits and costs of a program. In some tradeable permit regimes, the government agency must preapprove transfers and determine whether the impact on the environment from the trade is equivalent or acceptable. In other regimes, entities are free to trade without government approval. Greater government involvement might increase the level of assurance that environmental goals will be met, but also could increase transaction costs and regulatory uncertainty and so discourage trading. Also, some programs allow only entities targeted by the regulation to trade emissions, while other programs allow unregulated sources to "opt into" the market voluntarily.

Trading systems may vary due to a variety of factors, including the nature of the pollutant being traded, and how and if the program incorporates an existing regulatory structure. For example, the

[19] New Jersey found the early stages more time- and resource-consuming than expected. The DEPE found it took three months to review the first application for a facility-wide permit, rather than the estimated 30 days.

BOX 3-5: Debates About Integrated Permitting

Assurance of Meeting Goals

Promotes criterion: Integrated permits can help highlight requirements from multiple statutes that might conflict or otherwise hinder compliance. Multimedia integrated permits can reduce currently unregulated pollutants moving between media.

Impairs criterion: An integrated permit has such enormous data and analytical requirements that the tool faces a higher likelihood of failing to meet goals than simpler approaches. This approach requires monitoring sophisticated enough to track emissions between multiple sources.

Pollution Prevention

Promotes criterion: Integrated permits encourage agencies and applicants to look closely closely at facility processes, which may give pollution prevention an advantage.

Environmental Equity and Justice

Promotes criterion: An integrated permit program enables citizens groups to have input into numerous permitting decisions during a single comment period and hearing. The agency can consider multiple exposures from different environmental media as it develops and implements an integrated permit.

Cost-Effectiveness and Fairness to Sources

Promotes criterion: Integrated permits can achieve cost-effective abatement at the facility level, if they specify aggregate limits for entire facility.

Impairs criterion: The technical analysis required in support of a permit application can be burdensome, and beyond the capabilities of some firms.

Demands on Government

Promotes criterion.' Integrated permits may result in administrative cost savings in the long-run, The permits make it easier to evaluate a facility's compliance record, and whether enforcement actions are advisable, by combining all requirements in a single permit,

Impairs criterion: Integrated permits are likely to require additional administrative resources, at least in the short-run, They require analytically complex technical analysis to develop.

Adaptability

Promotes criterion: Integrated permits readily accommodate change in technology or market conditions, if the permit incorporates performance-based source limits,

Impairs criterion: Integrated permits can make changes to reflect new circumstances both difficult and resource-intensive, because of the permits' increased complexity.

Technology Innovation and Diffusion

Promotes criterion: Integrated permits might cause agencies and facilities to identity better-integrated technological solutions to pollution control.

SOURCE Office of Technology Assessment, 1995.

size of the geographic area over which trades are allowed will vary between trading programs because of the type of pollutant being traded. Widely spreading pollutants such as CFCs, with adverse effects at low concentrations found at distant points, are likely to have larger markets than pollutants such as carbon monoxide, with adverse effects primarily on a small local area. The larger the geographic scope, the more potential participants there are and a greater likelihood of a flourishing market. However, geographic scope inappropriate to the type of pollutant could decrease the likelihood that environmental goals will be met.

Another key variant is the extent the trading program's design and implementation accommodates existing regulatory structures. Many economists propose and analyze a trading system with few or no restrictions on trading. Yet, existing trading systems often require all sources to meet a minimum level of pollution control and allow trading of emissions only above and beyond that point. The effect of this limitation is that some of the emissions control cost savings available in theory are unavailable in practice.

Because emissions trading programs differ in design and in results, purported advantages and disadvantages of the regulatory tool should be viewed in the context of underlying assumptions about program design.

Note also that many evaluations of emissions trading include bubbles and netting. These regulatory alternatives involve transfers of emissions control responsibilities among sources in a single facility and not between facilities. Bubbles and netting are therefore outside the definitional scope of trading as used in this assessment and are considered as a form of integrated permit. However, discussions regarding cost-savings estimates and other potential program effects of trading often include bubbles and netting.

Extent of Use

Emissions trading has been extensively discussed in academic and applied literature, incorporated into environmental programs occasionally but with increasing frequency, and less often actually used by target entities. Empirical data is limited regarding the extent and effects of trading.

Emissions trading is most widely used under the Clean Air Act. The 1990 Clean Air Act Amendments broadly encourage the use of market-based approaches, including tradeable emissions. For example, states are authorized to use economic incentives as part of their air quality plans (232), the oxygenated fuels provisions allow trading of fuel characteristics, and chlorofluorocarbon provisions allow transfer of production allowances.[20] These programs are in their early stages, and so it is difficult to say how frequent trading is likely to be.

The 1990 Amendments also established the largest-scale tradeable emissions program to date, the acid rain program. The program seeks to impose a national cap on SO_2 emissions of 8.95 million tons. Utilities are issued tradeable allowances, with each allowance authorizing a source to emit one ton of SO_2 during or after a specified calendar year. To be in compliance, sources must have at least as many allowances as tons of SO_2 emitted. The first phase of reductions began in January 1995 for the highest-emitting utility units. The Chicago Board of Trade has held two allowance auctions, and utilities and other sources have announced a few dozen private trades (229). Generally, however, the level of trading activity has been lower than expected, though it is still too early to judge.

While the acid rain program was the first statutory environmental trading program, emissions trading actually first was proposed 14 years earlier

[20] EPA issued a temporary final rule pursuant to these provisions that permits transfer of CFC allowances among firms. 56 FR 49548 (Sept. 30, 1991) and 56 FR. 67368 (Dec. 30, 1991).

as an instrument for achieving air quality goals. EPA's 1976 Emissions Offset Interpretive Ruling allowed major new firms to locate in areas not meeting air quality standards, provided they "offset" their emissions with emission reductions obtained from existing facilities in the area (267). Modified and expanded in 1986, the air emissions trading policy has been less widely used than expected. Firms purchased offsets from others approximately 200 times between 1976 and 1986, and found offsets within their own preexisting facilities an additional 1800 times (72). Data are sketchy regarding trading since 1986.

Emissions trading has been used to address a number of other air quality problems, as well. For example, EPA used trading as part of its program to phase lead out of gasoline by 1987, to help reduce compliance costs and balance burdens between small and larger refineries (263,265,266). Telluride, Colorado, uses tradeable permits for fireplaces and wood stoves as a way to reduce particulate matter (29). Spokane, Washington, is implementing a program of tradeable grass burning permits to attain and maintain compliance with particulate matter standards (182).

The Regional Clean Air Incentives Market (RECLAIM) relies on trading to achieve cost-effective air emissions reduction in the South Coast Air Quality Management District (SCAQMD) of southern California. RECLAIM establishes an emissions trading market for stationary sources within the jurisdiction of SCAQMD that emit four tons or more of nitrogen oxides (NO_x) or sulfur dioxides (SO_2) per year.[21] Participating sources receive a permit that establishes regulatory obligations and includes an annual allocation of Regional Trading Credits (RTCs). An RTC represents one pound of either SO_2 or NO_x emissions and is a tradeable commodity available for sale or use within the year of its creation. Facilities must hold enough RTCs to cover their actual emissions. When initially implemented in January 1994, sources participating in RECLAIM included 41 SO_2 facilities representing approximately 85 percent of reported SO_2 stationary source emissions, and 390 NO_x facilities representing about 65 percent of permitted sources of NO_x (180). The program is designed to require emission reductions by 8.3 percent per year for NO_x and 8.6 percent for SO_2 from 1994 through 2003. SCAQMD estimates that the cost of emission reductions with RECLAIM would be one-quarter to one-third less than nontrading alternatives (181). RECLAIM is discussed further in chapter 2 of this assessment.

EPA and some states have considered emissions trading as a possible approach under the Clean Water Act, although the statute does not explicitly address such market-based approaches. Wisconsin established a program in 1981 that allowed trading of biochemical oxygen demand (BOD) between pulp-and-paper mills (38,275). The Wisconsin trading provisions have not been used. EPA worked closely with Colorado to demonstrate trading between point and nonpoint sources of phosphorus at Dillon Reservoir and Cherry Creek, Colorado. North Carolina has adopted a similar approach at Tar-Pamlico River Basin to control nutrients. These programs have not been widely used, but are expected to act as a safety valve as control requirements become more stringent (10).

Neither EPA nor the states appear to have used trading as an instrument to achieve goals under the Resource Conservation and Recovery Act. Most academic discussions of market incentives and waste management focus on pollution charges rather than trading.

Although regulatory agencies are adopting an increasing number of emissions trading programs, actual use of the programs by target entities has thus far been less than expected. Several factors may have contributed to the limited number of trades. For example, the trading program it-

[21] Separate trading markets exist for NO_x and SO_2. A volatile organic compound (VOC) market is in development and scheduled for adoption by fall, 1995.

self may limit trading. Limitations may arise from the existing regulatory structure, such as requirements that all sources meet a minimum level of control or that no permit control requirements be relaxed. Limitations may also stem from the trading program's design, which might geographically limit the market or specify that control cost savings alone are insufficient justification for a trade.[22] Another factor that may have helped to limit trading is the lack of clear property rights in traded emissions. Regulated entities might be discouraged from investing in additional controls or credits when the government may change the program at any time with no compensation for the lost traded emissions.[23] A third factor could be that the difference in control costs between facilities is less than originally estimated, thus reducing financial incentives to trade. Finally, transaction costs may discourage trading, including costs incurred to identify a willing buyer or seller and obtain any necessary government approvals.

Key Criteria Affecting Tool Selection

Assurance of meeting goals

One of the most hotly debated issues about emissions trading is whether the approach will achieve environmental goals. In theory, an emissions trading program should achieve environmental goals because the program places a cap on the total amount of permitted emissions, with the cap consistent with the goal. In practice, the environmental effects of trading are more complicated.

Trading increases the complexity of emissions monitoring, because of interfacility emission exchanges. To provide adequate assurance that environmental goals are being met, agencies must have adequate monitoring capability to track compliance with a trading program's multisource limits.

Trading programs may retain emissions that would otherwise be eliminated. For example, under some emissions trading programs, firms that are closing a facility may sell its emissions rather than retiring the emission reduction and creating a benefit to the environment. With trading, individual entities are not required to control pollution to the best of their abilities. Finally, compliance responsibilities of individual facilities may be more difficult to determine if a central register of emission permits and trading is not carefully designed.

Proponents of emissions trading note that, in some circumstances, trading may be the only method for achieving environmental goals. Where the remaining contamination problems stem largely from unregulated sources, trading offers an incentive for a regulated source to accept responsibility for controlling these sources in exchange for emissions control credit at its own facility. Also, many trading programs require a greater than 1:1 ratio between emission reductions and emission increases. While such trading ratios are typically adopted as a safety margin for environmental quality, potentially compensating for imperfect models and other uncertainties and not as a means to reduce emissions, such ratios could potentially have that effect.

Experience with trading programs indicates that trading may improve an agency's ability to determine compliance and environmental progress because requirements for increased monitoring have often been coupled with a trading program. For example, the acid rain allowance trading program requires continuous emission monitors (CEMs) on most regulated sources. However, it is important to note that the policy de-

[22] For example, the Wisconsin water discharge trading program does not allow trades solely to reduce treatment costs. Instead, dischargers are allowed to trade only if they are increasing production or are unable to meet current discharge limits using existing treatments. Wisconsin Stat. §212 (1981). See R.W. Hahn, "Economic Prescriptions for Environmental Problems: How the Patient Followed the Doctor's Orders," *Journal of Economic Perspectives* 3:95, spring 1989.

[23] For example, the acid rain trading program clearly states an allowance is not a property right, and Congress or EPA can change the terms of the program at any time. Clean Air Act, §403(f).

cision to require increased monitoring is independent of trading as a regulatory instrument.

Environmental equity and justice

The effect of emissions trading on environmental justice is speculative, at best, because little analysis has been done regarding trading's distributive impacts. Several public interest groups are concerned that emissions trading may result in an inequitable distribution of health risks and environmental contamination. These groups argue that the dirtiest companies, which tend to be located in poor and minority communities, will find it cheaper to purchase credits allowing them to maintain emission levels rather than to make the investment in emission reductions. At EPA hearings, environmental justice advocates have emphasized that "the money [from emissions trading] would go to Wall Street, the clean air would go to Westchester County and the pollution would go to East Saint Louis" (45). Some commenters argue that the only way to make trading programs environmentally just is to provide sufficient compensation to "victims of localized concentrations" (1), while others believe that adequate compensation is not always possible.

However, trading might result in exactly the opposite result: dirty sources in poor and minority neighborhoods would find emissions control cheaper than purchasing permits since their incremental control costs may be cheaper than cleaner sources. No evaluative data are available to indicate whether this actually occurs.

Some emissions trading programs attempt to address the problem of geographic inequities by requiring agency preapproval of all trades and conditioning approval on a finding that the trade will not adversely impact local air quality. For example, the air emissions trading program requires a greater than 1:1 emissions reduction, a showing of environmental equivalence, and a demonstration that the trade helps progress towards environmental goals (267). Trading programs also typically consider the nature of the pollutant being traded when setting geographic scope of the market. For example, the acid rain trading program places no geographic restrictions on trading, based on a conclusion that acid rain is a long-range transport problem rather than a local air quality issue.

Emissions trading may have a potentially adverse effect on a community's ability to shape environmental policy outcomes. Most environmental programs not incorporating trading provide an opportunity for public notice and comment on proposed permits, allowing a community to voice its views and potentially affect the terms of the permit. That voice could be lost if the distribution of emissions is allowed to shift according to market forces and not as the result of administrative processes. In theory, such communities are able to lower the magnitude of pollution by entering the market and purchasing emissions for retirement. The potential expense of such purchases may make this option to affect environmental outcomes unavailable.

Cost-effectiveness and fairness

One of the primary motivations for use of tradeable emissions is to achieve a given level of emissions control at the lowest cost. In theory, regulated entities should continue trading emission permits until their incremental costs of controlling pollution are the same, resulting in the lowest possible level of aggregate control costs. The magnitude of predicted savings depends on program design, treatment cost differentials across sources, the number of sources, the cost-effectiveness of the base case to which trading is compared, and other factors.

In practice, trading programs probably have not resulted in the cost savings that theory would predict. Most estimates of cost savings presume active trading until the economically efficient distribution of emissions control responsibilities is achieved. However, it appears that no program yet has had that level of trading, most have had limited trading, and some have had no trades at all. Thus savings estimates generally should be considered the likely upper bound of control cost savings from a particular trading program.

Even limited participation in a trading program might achieve a significant percentage of estimated cost savings if the program allows extreme results to be avoided. For example, trading might allow firms with very high relative incremental costs of control to meet emission requirements by the less expensive means of trading, rather than spending large sums to meet a uniform requirement with very little pollution reduced per dollar expended. In effect, much of the cost savings from trading might come from preventing very unwise actions rather than promoting clever, economically efficient ones.

Estimates made prior to program implementation often are the only indicators available as to cost savings from tradeable emissions programs. Actual cost savings data is lacking, in part due to an absence of program evaluation and because trading prices and control costs are often confidential (76). Table 3-4 illustrates cost savings from the most often-cited emissions trading programs. The table includes only actual programs and legislative proposals, not simulations of "ideal" trading programs. Note also that estimates for emissions trading include anticipated cost savings from bubbles and netting, which do not involve exchanges between facilities and so fall outside the definition of trading as discussed in this assessment.[24]

The fairness of emissions trading programs has received somewhat less discussion than its cost effects. Whether a trading program treats regulated entities fairly depends on such issues as initial allocation of emission credits, relative control costs imposed on different entities, and the rate of emissions reduction required for each entity.

The initial allocation of pollution control responsibilities will in large part determine whether emissions trading programs result in an equitable distribution among regulated entities. Trading will reallocate emissions among buyers and sellers, but the means of initial distribution must be decided by Congress or the regulating agency. The difficulty arises from the fact that large amounts of money potentially are at stake. The most commonly used initial allocation approach is a type of "grandfathering," in which tradeable emission permits are distributed according to some aspect of historical operations or emissions.

For example, Congress based the allocations of acid rain allowances on historical fuel use and sulfur content (196). RECLAIM allocated its emission credits based on "historic use" of each piece of NO_x- and SO_2-emitting equipment at a facility and subtracted the emission reductions necessary to comply with adopted rules. Grandfathering has the advantage of causing the least disruption to the status quo. Yet this approach might also be somewhat inequitable, as new entrants to the emissions market will have to pay for permits while grandfathered firms obtain them free. Other approaches to initially distribute emission allocations are possible, but have yet to be tried.

In theory, the method of initial allocation has no effect on the ultimate efficiency of the emissions trading program, so long as it does not create a monopoly by giving all emission permits to one firm.

Technology innovation and diffusion

One of the most often cited advantages of emissions trading is that it fosters technological innovation. Since emission reductions should be considered the equivalent of valuable and marketable emission permits, the incentives created by the trading program could stimulate innovation in the strategies and technologies used to reduce emissions. However, no actual data are available about the effects of tradeable emissions on technology innovation.

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[24] Bubbles and netting historically have been considered alongside emissions trading because they allow transfer of control requirements within a single facility. The 1986 Emissions Trading Policy Statement also discussed bubbles and netting. 51 FR. 43814 (Dec. 4, 1986).

TABLE 3-4: Potential Control Cost Savings From Existing Trading Programs And Legislative Proposals

Project name	Status of project	Nature of "data"	Control cost saving (compared to no trading)
Air emissions trading	In place; less use than expected	Retrospective estimation	$5.5-$12.5 billion since 1976a
Air acid rain trading	Early implementation; less use than expected	Prospective estimation	Between 40-45% ($.7-$1 billion) annually in SO_2 control[b]
RECLAIM	Early implementation	Prospective estimation	Between 25% and 33% lower in NO_x and SO_2 controls[c]
Lead phase-down in gasoline	Completed	Prospective estimation	Over $9.9 billion during 5-year program[d]
Wisconsin water trading program between point sources	In place; unused	Prospective and retrospective estimation	$6.8 million per year[e]; revised to $0 due to nonuse of program[f]
Dillon Reservoir point-nonpoint trading	In place; little used	Prospective estimation	51%9
Tar- Pamlico point-nonpoint trading	In place; unused	Prospective estimation	Between $188 and **$444** per kg nutrients controlled; 90%-75% in control costs[h]

[a] See A. Carlin, "The United States Experience With Economic Incentives to Control Environmental Pollution" (EPA Document No. EPA-230-R-92-0011 July 1992) at 5-14.

[b] 56 Fed, Reg. 63002, 63097 (Dec. 3, 1991).

[c] SCAQMD, "RECLAIM, Socioeconomic and Environmental Assessment," Final, v. Ill, p. 6-10, October 1993.

[d] S. Kerr, "The Operation of Tradeable Rights Markets: Empirical Evidence from the United States Lead Phasedown", paper presented at the AWMA Meeting "New Partnerships: Economic Incentives for Environmental Management", November 1993)

[e] O'Neill, David Moore and Joeres, "Transferable Discharge Permits and Economic Efficiency: The Fox River", 10 *Journal* Of *Environmental Economics and Management 346* (December 1983).

[f] Interview with E, David, Economist, Wisconsin Dept. Natural Resources, June 21, 1994.

[g] Apogee Research, "Incentive Analysis for Clean Water Act Reauthorization: Point Source/Nonpoint Source Trading for Nutrient Discharge Reductions" (Prepared for EPA Off Ice of Policy, Planning and Evaluation, April 1992) at 20.

[h] Apogee Research, "Incentive Analysts for Clean Water Act Reauthorization: Point Source/NonPoint Source Trading for Nutrient Discharge Reductions" (Prepared for EPA Office of Policy, Planning and Evaluation, April 1992) at 29.

SOURCE: Office of Technology Assessment, 1995.

Economic models have been used to predict the impact of tradeable emissions, and generally have found weaker links between trading and innovation than often asserted. One model showed no difference in incentive to innovate among tradeable emissions, pollution charges, and harm-based standards imposing similarly stringent standards (109). Another found that the incentive to innovate would vary from firm to firm, and that many firms would have less incentive to innovate under a tradeable emissions regime than under harm-based standards because they could buy their way around the need to reduce emissions (111).

Challenge Regulation

This policy instrument take its name from the fact that government *challenges* a group of sources to take the lead in designing and implementing a program for meeting environmental goals. Challenge regulation is distinguishable from other ap-

BOX 3-6: Debates About Tradeable Emissions

Assurance of Meeting Goals

Promotes Criterion: Trading can bring otherwise unregulated sources under control.

Impairs Criterion: Trading can result in "hot spots. " Noncompliance is hard to detect because of interfirm pollutant movement, unless monitoring is improved.

Pollution Prevention

Promotes Criterion: Trading can leave sources free to choose between control equipment or process changes for emission reductions,

Impairs Criterion: Trading tends to focus on reductions in releases more than on reductions in pollution generated,

Environmental Equity and Justice

Promotes Criterion; "Dirty" sources, which are often in poor/minority neighborhoods, are likely to find control cheaper than purchasing permits, since their incremental control costs may be lower than cleaner sources.

Impairs Criterion: Trading distributes emissions according to market forces, not by an open administrative process that allows community input, and might perpetuate an existing inequitable pollution distribution,

Cost-Effectiveness and Fairness to Sources

Promotes Criterion: Trading provides incentives for regulated entities to identify cheaper ways to control emissions beyond their own "target." Large cost savings might result from even limited use of trading, if entities with the worst ratio of cost to environmental benefit participate.

Impairs Criterion: Estimated cost savings assume a heavy volume of trading, which has not occurred in practice. "Grandfathering" as an initial permit allocation method can result in an inequitable distribution.

Demands on Government

Promotes Criterion: Trading reduces the need for government to identify control technologies.

Impairs Criterion: Agencies implementing trading have found increased workloads in the early stages of implementation.

Adaptability

Promotes Criterion: Trading allows entities to adopt a new technology, so long as it meets emission requirements. Agencies can change aggregate emissions by not reissuing expired permits or by issuing additional permits.

Impairs Criterion: Property rights raise questions about government's ability to adapt the number of permits to changing circumstances.

Technology Innovation and Diffusion

Promotes Criterion: Trading fosters innovation, because a potential to reduce emissions below any individual source's allocation has market value.

Impairs Criterion: Some economic models show trading is neutral or discourages innovation, because entities holding tradeable credits might not want their value diffused by new cheaper control technologies,

SOURCE: Office of Technology Assessment, 1995,

proaches by its configuration of the following key elements:

- government establishes clear, measurable targets, either risk-based or technology-based, with a timetable for implementation;
- the targets are defined for multiple sources, usually at the industry sector or geographic level, rather than for individual facilities;
- these sources are given the collective responsibility for designing and implementing a program for meeting the targets; and
- government specifies a credible alternative program or sanction, which will be imposed should progress toward targets be unsatisfactory.

The shift in responsibility for program design and implementation—toward the sources themselves and away from government—is the truly distinguishing feature of challenge regulation. With this responsibility, the group of sources also accepts the costs and administrative burdens of developing a program that will be effective in meeting the targets. Challenge regulations are *not* voluntary.

For the sources, a challenge regulation functions like a "meta-performance standard" (104) for which a targeted group of sources has the flexibility to choose whatever means—not only technological, but institutional as well—they believe would be best for meeting the target. Although the sources may choose to adopt a familiar approach such as design standards, they may also come up with innovative or varied approaches, such as a trading program or a fee system to meet the established targets. If allocation of responsibility for reductions in emissions or discharges is required, the sources will have to determine how to make those allocations themselves. The industry may also decide to use the challenge to share information, technologies, or personnel to solve common problems.

Under challenge regulation, a major governmental task is to set clear, measurable targets, either risk-based or technology-based, with a timetable for implementation. These targets, combined with a reasonable compliance schedule and specific monitoring protocols, may reduce some of the uncertainty which sources have identified as a barrier to investing in innovative solutions. These targets would be defined for multiple sources, typically for an industry sector, rather than for individual facilities. However, multiple sectors could also be challenged to meet goals.

Government also retains the responsibility and authority to specify a credible alternative program or sanction to be implemented should industry fail to meet the targets within the specified timetable. In addition, depending on the problem being addressed, the government might be involved in providing information, technical support, or other assistance during the design and implementation phases. Industry may seek clarification, for example, regarding the kinds of monitoring protocols which will be acceptable to the government agency for measuring progress toward the target.

Extent of Use

Challenge regulation has not yet been extensively adopted by any country, although OTA has identified several programs with similar elements. In the United States, the program most similar to a challenge regulation is the 33/50 program associated with the Toxics Release Inventory, EPA's annual measure of toxic chemicals, releases, transfers, and waste generated by manufacturing facilities. The major difference between 33/50 and OTA's challenge regulation is the fact that 33/50 is a voluntary program.

When announcing the 33/50 program, EPA suggested that it was thinking about issuing regulations to control emissions but wanted to see how far industry could go on its own. For 17 high-priority toxic chemicals, EPA backed the voluntary targets of 33 and 50 percent reductions in emissions in 1992 and 1995 compared to a 1988 baseline, implying that the agency would issue rules and regulations should industry fail. This is similar to challenge, albeit a much softer "stick" than the sanctions or alternative regulatory programs associated with a challenge regulation.

EPA's Common Sense Initiative uses an industry-by-industry approach, similar to that used by challenge regulation in some circumstances, and relies on negotiations with industry and company officials to determine feasible improvements for environmental performance. This approach is often used in European countries where the tradition of working closely with industry groups is well established. In the United States, explicit cooperation with industry has been more difficult than in Western Europe, primarily because of conflict-of-interest concerns. EPA's Common Sense Initiative goes beyond its voluntary public-private partnership approach by incorporating strong enforcement efforts into the agreement.

A number of other European nations, Canada, and Japan, have also implemented programs with some of the same elements of challenge regulation for dealing with both process and product regulation. The most widespread use of challenge approaches has been to establish producer responsibility for various forms of wastes to encourage source reduction and recycling.

The most ambitious of these programs to date has been Germany's Green Dot program which incorporated all of the elements of challenge regulation. The federal government's 1991 Packaging Ordinance was enacted to reduce the volume of packaging waste and improve the overall materials policy. The government established a regulatory approach outlining industries' obligations to take back packaging from customers. However, the government then gave industries the opportunity to establish an alternative program of their own for meeting the targeted rates. In addition to shifting the responsibility for source reduction and recycling of packaging materials to the industries producing the materials, the government required them to develop a system for handling the materials entirely separately from the existing public solid waste system. The industries cooperated to establish the Green Dot program based on an industry-imposed fee system to support and manage the recycling system. In addition, firms began to work internally as well to reduce the quantity of disposable packaging (53).

The German program has experienced a number of difficulties and been widely criticized (53). For example, the very short timetable for industries to comply and the stringent recycling targets may have contributed to an emphasis by industry on recycling rather than source reduction. The industries also underestimated the costs of managing such a recycling effort, resulting in the threat of bankruptcy of the Green Dot program. In addition, some companies printed the green dot label on their products, indicating they were participating in the program and had paid their fee when, in fact, they were free riders. According to Inform, about 90 percent of the packaging carried green dots but fees were only paid for about 50 to 60 percent of the packaging.

The Netherlands' National Environmental Policy Plan (NEPP), initiated in 1989 and revised in 1993, is implemented in part using elements similar to challenge regulation. The Dutch government adopts medium- and long-range measurable targets and timeframes (usually between five and 15 years) and identifies the industry sectors or firms responsible for changes. It then asks these targeted sources—usually industry sectors—to develop implementation strategies for solving problems, and enforces the targets and timeframes.

The national government usually negotiates with industry groups, and often with larger individual firms, to establish the implementation plans for meeting targets. These plans are then formalized through covenants or formal, written agreements between government and industry. The purpose of these agreements is to allow some flexibility for learning and experimentation. However, even though the approach begins as a "voluntary" agreement, the negotiated covenant is typically enacted into law to increase the dependability of the agreements. In addition, industry must comply with local authorities' licensing and permitting requirements until the covenant provisions can be incorporated into the local requirements.

The Netherlands' use of target groups—such as agriculture, traffic and transport, and refineries—as the basis for implementing emission reductions is similar in concept to the EPA's Common Sense

Initiative described above. Within these larger target groups, the Dutch identify subgroups that they characterize as heterogeneous or homogeneous industries, according to industry characteristics. The printing industry, for example, is considered homogeneous in terms of process technologies; thus a fixed target can be set for the entire industry and a plan for reaching the goal worked out and signed with the entire group of sources. In contrast, the chemicals industry, which is more heterogeneous, requires that the government negotiate on a firm-by-firm basis to develop implementation plans for meeting a particular target and timetable.

Transferring the European experiences to the United States would require some caution. For example, the small size of the Netherlands, the relatively few large companies, the substantial membership in trade associations, and most important, the tradition of "corporatism" or acknowledged cooperation between government and those with the expertise and a clear stake in policy development, are quite different from the United States. In addition, it is too early to be sure that the Dutch NEPP approach has been completely successful (39). Like the United States, the Dutch are struggling to find the best way to involve localities in defining an acceptable covenant with industry when programs are being developed to meet national targets. Existing permits and licenses at the local level, for example, continue to take priority over covenant agreements until they can be reconciled as they come up for renewal or can be revised. In addition, the scale of the Dutch experiment may make it less reliable as a benchmark for the United States. Nonetheless, as with the German Green Dot experiment, much can be learned from the experiences of other countries in using challenges to sources as an instrument for meeting environmental goals.

Key Criteria Affecting Tool Selection

Environmental equity and justice

Since industry is responsible for designing and implementing the program, there is no guarantee that distributional concerns about the effects of pollution will be adequately considered. Thus, challenge regulation must be used with care for reducing pollutants or solving other problems for which exposures vary widely across locations. The outcome, of course, depends on the approach actually chosen by the affected industry. If the chosen approach relies on emissions trading or pollution charges, then the cautions identified for each of these instruments would apply. If the affected industry opted for a program employing the single-source tools described earlier, the outcome with respect to environmental justice would be about average.

However, use of a challenge regulation approach may have a potentially adverse effect on economically disadvantaged and minority communities' ability to shape environmental policy outcomes. While the goal and deadlines set by the government would be subject to notice and public comment, what industry chooses as the means to reach those goals and deadlines generally would not be.

Cost-effectiveness and fairness

The major advantage of challenge regulation is that it shifts the responsibility for designing and implementing programs to a group of sources—that is, to the individuals, firms, and networks—with the expertise and experience to develop the most cost-effective ways to meet environmental goals. Challenge regulation creates flexibility both in terms of scheduling and the means of meeting ultimate targets. This flexibility allows industry to change those sources and methods with the least expensive abatement costs, and to experiment with process changes that might have a high payoff in performance and lower costs.

By emphasizing negotiation and bargaining among firms within an industry rather than adversarial contacts between government and industry, challenge regulation is likely to reduce overall transaction costs as well. Although the costs for industry are likely to increase for planning and coordination of the program, presumably the costs of implementation will be cheaper than had the government imposed a program on firms—or at the least, firms would have been given the opportunity to design a more cost-effective program, if possible. In addition, the overall administrative costs may actually be lower because there are fewer opportunities to participate in rulemaking procedures.

In any case, industry is likely to believe that it can design a program that would be better than any alternative regulatory program government would develop. Limited experience with the challenge approach makes it difficult to know whether or not this will always be true.

In terms of fairness, industry groups could be expected to prefer having control over determining how to meet targets rather than allowing government to direct their activities. However, competition among firms may sometimes make it difficult to satisfy all of the firms who have responsibility for meeting the targets, no matter how fairly the targeted group tries to be in allocating responsibilities.

Demands on government

The overall demands on government for implementing challenge regulations may be less than for programs using approaches such as source-by-source standards, because the role for government narrows to one of assistance, oversight, and enforcement. Also, government agencies generally would not be required to submit the proposed means of achieving goals to public notice and comment, thereby making their administrative costs lower.

However, the agency must design an alternative regulatory program or sanctions to be used should industry fail to meet its targets. In addition, developing capacity for implementing challenge regulations may require reorientation of personnel toward such skills as providing technical support and assistance, and negotiation and bargaining. The agency would continue its enforcement efforts and devote more resources to developing monitoring and information reporting data systems, and inspection and compliance regimes.

Adaptability

Another potential advantage of challenge regulation is that if industry so chooses, it can make its approach more adaptable to new information or technologies. Rather than waiting for EPA or state agencies to recognize new technologies or approve process changes, industry could choose to design a program with some flexibility for experimenting and identifying new opportunities for improvements.

Given the lack of experience in implementing challenge regulations, it is difficult to know what kinds of programs industry would choose. It is possible that an industry would develop a very flexible program that could adapt easily to changing scientific and technological information. It is also possible that industry would put in place a program that guarantees a relatively high level of certainty to firms regarding what they have to accomplish in order for industry to meet the targets on schedule. Once a structured program is place—whether it is a parallel waste system like that set up under the Green Dot program, a technology-based design standard, or an allocation of emission reductions for each firm—industries may find it just as difficult to adapt to new information as they would had government imposed the program.

Technology innovation and diffusion

Although challenge regulation will not force innovation or diffusion of technologies, it does offer industry an opportunity to reduce some of the barriers to those activities. For many firms, the most crucial barrier to incremental innovations, which are so important for firm competitiveness and profitability, is a delay in implementation caused by external factors such as the need to obtain permit revisions or waivers.

Another advantage of challenge regulation is that it can result in firms within an industry organizing in the manner they believe the most effective in reaching the goals. In the chemicals industry, for example, firms may want to hold process technologies closely rather than disseminate corporate information. However, through a trade association like the Chemical Manufacturers' Association, industries may be able to share information about control technologies or best practices.

TOOLS WITHOUT FIXED POLLUTION REDUCTION TARGETS

A second major category of environmental policy tools encourages pollution prevention and control without setting specific emissions control requirements.

Some of these instruments are non-regulatory in nature, while others require a particular action, such as payment per unit of emissions or an emissions report. Note that even the regulatory tools in this category require something other than a specific level of pollution prevention or control. Tools that encourage environmentally sound behavior fall into two groups: 1) tools that make it easier or less expensive to lower pollution by providing knowledge or financial assistance, and 2) tools that raise the financial stakes of continuing to behave in environmentally harmful ways.

Tools that increase the cost of environmentally harmful behavior include pollution charges, information reporting, and liability. These tools are based on the assumption that sources will emit less if their pollution costs them something, either as direct payments to an agency or harmed parties or indirectly in terms of reputation.

Tools that encourage facilities to prevent or control pollution include subsidies and technical assistance. Both approaches assume that sources will be willing to change once they know of the benefits of alternative types of behavior, and are more likely to change if the expense is at least partially offset by others.

Pollution Charges

With pollution charges, a regulated entity is required to pay a fixed dollar amount for each unit of pollution emitted or disposed; these charges may, to some extent, be considered the "price" to be paid for pollution. Pollution charges do not set a limit on emissions or production. Instead, the government must calculate what level of charge will change the behavior of regulated entities enough to achieve environmental objectives. Sources are free to choose whether to emit pollution and pay the charge, or to pay for the installation of controls to reduce emissions subject to the charge. When used as a policy instrument, pollution charges are set at a sufficiently high level to provide significant financial incentives to reduce or even eliminate environmentally harmful behavior.

Pollution charges raise revenue that can be used to operate the program or go to general revenues. Pollution charges are used widely as a revenue-raising instrument, set at a level adequate to help fund regulatory programs but too low to significantly change behavior. This OTA assessment is not focusing on pollution charges designed only to generate program revenue.

Much of the economic literature focuses on the potential of pollution charges to send accurate signals to entities about the cost of using the environment's capacity to assimilate waste and to force entities to pay for the full societal costs of their pollution—"internalizing the externalities," in economic jargon. However, setting a pollution charge at a level that accurately reflects full societal costs—neither higher or lower—is probably impractical because of the enormous analytical and data requirements required.

In order to act as an incentive, pollution charges must vary according to the amount of pollution produced. Such variation can provide a direct incentive for sources to cut back on their emissions and waste. Flat rate structures provide little incentive to reduce pollution. For example, a uniform solid waste disposal fee per household that is unrelated to the amount generated does not provide an incentive to reduce waste.

Extent of Use

Pollution charges set at a level sufficient to change behavior are not often used in the United States, except for solid waste management. They are widely used to generate program revenue in Europe and, to an increasing extent, in the United States.

BOX 3-7: Debates About Challenge Regulation

Assurance of Meeting Goals

Promotes *criterion:* The "credible threat" component provides a basis for mandatory compliance at a later date if industries do not cooperate. Challenge regulation has the potential to promote a less adversarial style among interested parties,

Impairs criterion: Allowing industry temporary discretion risks "lost time" toward achieving environmental goals if they fail.

Pollution Prevention

Promotes criterion: Challenge regulation leaves sources free to choose between control equipment or process changes for emission reductions.

Impairs criterion: Challenge regulation provides no particular incentive to prefer reductions in pollution generated over abatement technologies.

Environmental Equity and Justice

Impairs criterion: Challenge regulation does not provide the kinds of explicit mechanisms for third-party participation in decisionmaking that other regulatory tools do provide.

Cost-Effectiveness and Fairness to Sources

Promotes criterion: Challenge regulation provides opportunity for industries to find interfirm solutions and lowest control cost. It allows interfirm negotiation on the means for accomplishing goals in a way the firms believe is fair.

Impairs criterion: Industries may not pursue cost-effective approaches as diligently as individual firms might. Some firms, especially small ones, may not believe they are treated fairly by dominant firms in their industry.

Demands on Government

Promotes criterion: Personnel can be directed towards providing technical support and assistance, Resources and time previously required for rulemaking under the Administrative Procedures Act are reduced.

Impairs criterion: Initial efforts to implement challenge regulations maybe difficult, Government must invest resources in designing an alternative program as a backstop should industry fail to meet goals by the deadline.

Adaptability

Promotes criterion: Industries can adjust their strategies more quickly to new information than can government agencies. Industry expertise and networks are attuned to anticipating changes or new opportunities.

Technology Innovation and Diffusion

Promotes criterion: Allowing or encouraging industry collaboration may facilitate technology innovation or diffusion.

Impairs criterion: Challenge regulation may require changes in antitrust rules to allow collaboration among firms.

SOURCE Office of Technology Assessment, 1995.

Pollution charges are most often used in the United States for collection and disposal of commercial, industrial, and household waste. Commercial and industrial sources typically pay charges that rise as waste volume rises, while most households face flat fee schedules unrelated to the amount of waste generated. Volume-based charges are becoming more common for household waste. In approximately 100 jurisdictions, charges for waste collection are based on volume, rather than a fixed price per month. Charges are typically levied by subscription for a specific number of containers, or by stickers that must be placed on any bag left for pickup. Lubricating oils, lead-acid batteries, and car hulks have been proposed as possible candidates for user charges in the United States.

Pollution charges are used less commonly under the Clean Water Act. Charges for National Pollutant Discharge Elimination System (NPDES) permits are typically set at a level intended to raise program revenue and not to provide a significant incentive to reduce emissions. Publicly owned treatment works (POTWs) charge fees for industrial facilities and households that discharge into their systems. The charge for industrial sources may be based on the types and amounts of pollutants present or on volume. Generally, only larger sources pay pollutant-based charges, because of high monitoring costs (29).

In 1992, the New York legislature considered Senate Bill 1081, which would have established a pollution charge program for point sources of water pollution. The program was intended to achieve defined goals for the reduction of pollutant loadings, and not to meet a budget-based revenue target. The bill proposed a charge schedule with rates based on toxicity, quantity, and heat content. The pollution charge would be adjusted for inflation annually and would automatically increase by 25 percent if the environmental goals were not achieved by a specified date (151). The bill was not enacted; however, interest in pollution charges appears to be growing.

Air emission charges most often are set at a level designed to recover administrative costs of state air quality programs, rather than to provide a significant incentive for sources to reduce their emissions. The South Coast Air Quality Management District in the Los Angeles area has what may be the highest air emissions fees in the country.[25] Annual permit fees for the largest sources can amount to $2 million or more, an amount likely to attract attention of source managers. However, a source's ability to respond to the pollution fee incentive is limited in the SCAQMD jurisdiction because the incremental control costs for most sources in the region are so high (29).

The Clean Air Act Amendments of 1990 provided for a variety of pollution charges. Most of these, such as the permit charge of $25 per ton of regulated pollutants, are designed to recover administrative costs. Another provision requires sources in extreme ozone nonattainment areas—currently only the SCAQMD area—not attaining standards by 2010 to pay emission charges of $5,000 per ton (adjusted for inflation) for each ton of VOC emitted that exceeds 80 percent of a baseline quantity (236). Depending on the cost of incremental emission controls, such a charge might provide a significant incentive to reduce emissions. Pollution charges are also specifically authorized under the Economic Incentive Program Rules (234).

The charge on CFCs appears to be set at a level sufficient to cause change in target entities' behavior (193). During the CFC phaseout period beginning in 1990, users must pay a charge per pound of CFCs, multiplied by an ozone depleting factor.[26]

[25] Major sources (emitting over 75 tons per year) must pay $596 per ton for organic gases, $343 per ton for nitrogen oxides, $413 per ton for sulfur oxides, and $456 per ton for particulate matter. A. Carlin, *The United States Experience with Economic Incentives to Control Environmental Pollution*, EPA-230-R-92-001(Washington, DC: July 1992).

[26] The tax began in 1990 at $1.37 per pound, was increased to $3.35 per pound in 1993 and to $4.35 in 1994, and is scheduled to increase to $5.35 in 1995.

By the end of 1991, CFC production was down to 60 percent of 1986 production levels. This decline in CFC use is a much more rapid phasedown than originally anticipated. The role of the CFC tax in this decline in use is believed to be extensive, particularly in industrial sectors where the CFC cost is itself the major cost factor (193).

Pollution charges are used more frequently in Europe than in the United States. The Organisation for Economic Cooperation and Development (OECD) reports that member countries are using emission fees to address a variety of air pollutants, primarily SO_2 and NO_x, as well as household or industrial waste and hazardous waste. For example, Sweden has placed charges on NO_x emissions, in order to speed up compliance with new emission guidelines to be imposed in 1995. Charges are levied on the actual emissions of heat and power producers with a capacity of over 10 MW and production exceeding 50 GWh. The fees are then rebated to the facilities subject to the charge, but on the basis of their energy production. Thus funds are redistributed between high- and low-emitting facilities. In 1992 the actual emissions reduction was between 30 and 40 percent, exceeding the predicted 20 to 25 percent reduction. Several OECD member countries are also levying a pollution charge on landfilled and incinerated wastes, as well as experimenting with pay-per-bag systems.

Key Criteria Affecting Tool Selection

Assurance of meeting goals

Pollution charges do not dictate with certainty how much control will occur. Firms can choose to pay the charge for emissions or to control emissions; their decision depends on the specifics of their own situation.

The degree of assurance strongly depends on how accurately an agency has set the fee. For a fee to be set at a level to achieve a particular environmental goal, an agency would need detailed information about targeted entities' internal economics and control costs in order to predict firms' pollution control strategies, and must understand the relationship between emissions, health effects, and the environmental goal. As a result, agencies would probably set a charge level believed to be roughly high enough to achieve program objectives, with the expectation that the fee would be adjusted as monitoring and other data indicate is desirable. The more approximate the fee level, the lower the degree of assurance.

The ability of pollution charges to achieve environmental goals also is influenced by many of the same issues affecting other policy instruments. First, target entities do not always react to economic incentives or potential noncompliance penalties the way economists predict that rational economic actors will behave (224).

Second, monitoring emissions of the relevant pollutant must be easy to do and hard to circumvent. If emissions are hard to monitor, some emissions will go untaxed and the incentive to install pollution control technologies will be reduced. If emissions monitoring is easy to circumvent, some sources might choose to control less and avoid additional charges via inaccurately recorded emissions. Similarly, incentives for illegal dumping might be created if the pollution fee was imposed at the point of disposal rather than automatically at an earlier point of the product manufacturing, use, and disposal chain (40). It is important to remember that unpredictable responses and compliance avoidance are hardly unique to pollution charges.

No empirical data are available on the effects of pollution charges on air or water emissions or environmental quality. The pollution control literature does not discuss actual experience of commercial and industrial waste generator responses to varying charges for hazardous waste (29). Some data are available for the effects of pollution charges on solid waste collection and disposal. As illustrated by table 3-5, pollution charges based on volume of waste collected and disposed appear to create a significant incentive to reduce waste.

Environmental equity and justice

Pollution charges may have a potentially adverse effect on economically disadvantaged and minority communities' ability to shape environmental

TABLE 3-5: Effects of Pollution Charges on Solid Waste Collection and Disposal

Program	Type of fee	Type of pollutant	Nature of "data"	Environmental results
High Bridge, NJ	Emissions (pay-per-bag)	Solid waste	Empirical	24% reduction in tonnage[a]
Perkasie, PA	Emissions (pay-per-bag)	Solid waste	Empirical	50% reduction in tonnage; **30%** increase in recycling
Seattle, WA	Emissions (pay-per-bag)	Solid waste	Empirical	20% reduction in tonnage[c]

[a] L. Lave and H. Gruenspecht, "Increasing the Efficiency and Effectiveness of Environmental Decisions: Benefit-Cost Analysis and Effluent Fees", 41 *Journal of Air and Waste Management 680,690* (May 1991).

[b] A. Carlin, "The United States Experience With Economic Incentives to Control Environmental pollution" (EPA Doc. No. EPA-230-R-92-001 , July 1992) at 3-3.

[c] A. Carlin, "The United States Experience With Economic Incentives to Control Environmental Pollution" (EPA Doc. No. EPA-2 at 3-3

SOURCE: Off Ice of Technology Assessment, 1995.

policy outcomes. While the regulatory decision of what the fee level is set at is likely to be subject to public notice and comment, a facility's decision about its emission levels would not be. Thus, pollution charges might lessen the opportunity for communities to voice their views and potentially affect emission levels.

Technology innovation and diffusion

Pollution charges, like emissions trading, allow firms enormous flexibility in deciding the level and means of emissions control. Pollution charges can create a continuing internal incentive to develop cheaper and more effective ways of controlling pollution so as to reduce the size of the charge payable. However, because pollution charges are not widely used, little actual data exists regarding their effects on technology innovation.

Pollution charges levied on polluting inputs may provide an incentive to develop safer new products or less harmful substitutes, as well as raise product price, which reduces the amount demanded (193). Similarly, increased charges for collection and disposal of household solid waste might lead to new types of consumer products packaging that create less waste.

▮ Liability Provisions

Liability provisions require those entities undertaking activities that impose pollution or other environmental harms on others to pay those who are harmed to the extent of the damage. Liability can provide entities with a significant motivation for environmentally sound behavior because the dollar amounts involved can be huge. Liability is imposed two ways: 1) by common-law theories like negligence or nuisance, or 2) by statute, such as in the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA).

Liability provisions are different from enforcement. Liability compensates those who are harmed, while enforcement penalties and incarceration discourage and punish noncompliance.

Liability as a policy tool may vary widely, depending on the specifics of a program. Some forms of liability arise only if an entity is shown to be "negligent," that is, as not having exercised reasonable care in its activities. Alternatively, liability might be "strict," where one who engages in an activity that causes a harm is liable even if shown to have used reasonable care. Federal environmental statutes most often contain strict liability provisions. For either type of liability, a successful claim typically requires an established causal link between the harm and the pollution, which has been traced back to its source. Claimants might be parties seeking reimbursement for remediating a pollution problem, or injured parties, or any member of a group specified in the statute establishing a liability system. Forums where liabil-

BOX 3-8: Debates About Pollution Charges

Assurance of Meeting Goals

Promotes *criterion:* Charges provide incentives to control emissions beyond their own "target."

Impairs criterion: Charges do not dictate with certainty the level of pollution control.

Pollution Prevention

Promotes *criterion:* Charges leave sources free to choose between control equipment or process changes for emission reductions.

Impairs criterion: Charges provide no particular incentive to prefer reductions in pollution generated over abatement technologies.

Environmental Equity and Justice

Promotes criterion: Charges can provide revenues for offsetting disproportional negative environmental impacts.

Impairs criterion: Charges set emissions levels and distribution according to market forces, not open administrative processes. Uniform charges do not address "hot spots."

Cost-Effectiveness and Fairness to Sources

Promotes criterion: Charges set a uniform upper bound on control costs. Economically rational entities will achieve a target level of emissions at least cost.

Impairs criterion: Once an environmental goal is reached, entities still must pay for emissions.

Demands on Government

Promotes criterion: Once set, charges can be simple to administer, particularly if charges are uniform. Charges can generate revenue for administration and other public purposes.

Impairs criterion: Setting charges at level calculated to achieve a particular emission reduction goal is analytically burdensome and data-intensive. Charges may require ongoing "finetuning" to get desired pollution abatement level.

Adaptability

Promotes criterion: Entities are free to adopt new technologies.

Impairs criterion: Pollution charges are subject to time-consuming public notice-and-comment procedures required under the Administrative Procedures Act.

Technology Innovation and Diffusion

Promotes criterion: Charges provide a continuing incentive to innovate, as a way of reducing the size of the charge, and provide considerable flexibility as to control techniques.

SOURCE: Office of Technology Assessment, 1995.

ity claims might be asserted include government administrative proceedings, private claims disbursement processes, and courts.

A facility is not insulated from future liability even if in full compliance with today's regulatory requirements, including discharge limits or disposal practices specified in a permit. Statutes can authorize retroactive liability, as did CERCLA for wastes disposed prior to its enactment. Also, commen-law claims might be successful even where an entity was fully in compliance and a statute exempted permitted discharges from its liability scheme. Potentially enormous financial exposure could encourage entities to reduce their use, generation, emission, and disposal of hazardous substances or other pollutants, and to implement controls and safety procedures beyond those required by direct regulation. Liability also may provide incentives for environmental auditing and other self-appraisals, in order to gauge the potential financial exposure and correct problems before they grow.

Like most policy tools, liability is an effective incentive for environmentally beneficial behavior only to the degree liability impacts the decisionmaker. Factors that might affect such incentives include whether decisionmakers bear responsibility within their organizations for their decisions, if it is foreseeable that others might be harmed, the time lag between managerial decisions and eventual lawsuits, and the extent insurance protects the organization from the effects of liability (120,162). The likelihood of being held liable is also affected by whether the contamination is traceable back to its source, if impacts are sufficiently concentrated to make a claim worthwhile to the injured party, and if the contamination stems from one or multiple sources.

This OTA assessment is focusing on liability provisions established by statute and not upon common-law foundations. However, the policymaker establishing statutory liability should consider how those provisions interact with the common-law system. For example, should the statutory scheme preempt, supplement, or coexist with common-law claims?

Extent of Use

CERCLA or Superfund is an example of strict retroactive liability that can cost millions if an entity is found liable for a Superfund site cleanup. Under CERCLA, governments may collect cleanup costs and the value of damages to natural resources from any or all waste producers[27] that used a particular site, entities that arranged for waste disposal or treatment, those who transported waste to the site, and present and past "owners or operators" of the site (248). Private individuals also can sue to recover cleanup costs; however, liability is restricted to damages to publicly owned or controlled natural resources and does not include harm to private parties. As a result, claims for private property damage or personal injury cannot be brought under CERCLA. As of 1994, the average cost of cleaning up a Superfund site was approximately $30 million.

Other federal statutes address harm to private parties and impose liability on entities that have caused the harm. For example, entities that spill petroleum into surface waters are strictly liable under the Oil Pollution Act (OPA) for cleanup, natural resource damages, and third party damages caused by the spill (244,253). The OPA places limits on liability. However, these limits probably do little to impair incentives for environmental compliance, because the liability limits are so high and can be overcome by a showing that a release resulted from violation of a safety or operating standard. In addition, the OPA does not preempt states from imposing more stringent liability schemes.

The Clean Water Act (CWA) makes responsible parties liable for cleanup costs for a spill of hazardous substances into surface waters. Liability is capped at $50 million unless the discharge was the result of willful negligence or willful misconduct (245). The CWA does not preempt stricter state liability provisions.

Liability costs, therefore, can be extremely large under the CWA and the OPA, as illustrated by Exxon's experience following a large oil tanker spill into Prince William Sound in Alaska in March 1989. As of September 1994, Exxon had already spent $3.4 billion to clean up the spill and settle federal and state suits for cleanup reimbursement and natural resource damages. In addi-

[27] This type of liability is known as "joint and several," where each party who contributed to the problem is responsible for the entire cost of cleanup, and not just its proportionate share.

tion, a jury awarded $5 billion to Native Alaskans and fisherman for third party damages—roughly equivalent to a year's worth of Exxon profits.[28]

CERCLA, CWA, and OPA all contain defenses to liability, which if applicable could allow the source of a pollution emission to avoid responsibility for reimbursement and compensation to injured parties. These defenses apply only in narrow circumstances. Liability is avoided only if the source can prove that an emission was caused solely by an act of God, an act of war, an act or omission by a third party, or (under the CWA only) negligence on the part of the U.S. government.

Key Criteria Affecting Tool Selection

Pollution prevention

Liability probably provides a moderate incentive for entities to practice pollution prevention. Data on actual effects are lacking, however.

When effectively implemented, liability creates an incentive to reduce pollution. Firms theoretically will seek out pollution reductions wherever they are cheapest. Thus, like many other instruments, whether liability results in pollution prevention or control will vary from site to site, depending on the relative costs of different pollution reduction strategies.

However, liability might offer encouragement for pollution prevention if available end-of-the-pipe solutions result in residuals that could become a source of future, retroactive liability. In such a situation, entities have an incentive to prevent pollution in the first place rather than risk potential future liability.

Demands on government

Liability imposes demands on government in essentially two contexts: as a claimant seeking compensation, and as operator of the court or administrative system through which claims are made.

The government is often in a position to claim compensation for cleanup costs and natural resource damages. The likelihood of collecting depends in part on the government resources expended pursuing claims and administering the liability program. The more resources expended, the more likely it is that a claimant will establish the required elements of a successful claim. Anecdotal evidence indicates that some types of successful claims can be very expensive to make.

Causality—that the injury is caused by pollution that comes from actions of a particular entity—can be particularly difficult and expensive to prove for some kinds of damages. Linking pollution with cleanup costs or with injuries to natural resources may not be that difficult in circumstances where the pollution is traceable. Identifying the source may be difficult if pollutants are broadly dispersed, or if the damage is believed to come from diffuse mass exposure with a long latency risk.

While scientific developments in the last 30 years have shown convincingly that man-made pollutants can cause serious health and environmental problems, conclusions are often expressed as statistically likely cancers per number of population. As a result, it is still very difficult to conclusively demonstrate that a particular individual's harms stem from a particular exposure.

Assessing the extent of damages also can be administratively expensive, sometimes exceeding the extent of damages themselves. For example, a study of the December 1985 Arco Anchorage crude oil spill of 5,700 barrels could detect damages of only $31,930, while assessment costs amounted to about $245,000 (69,219). Other types of damage, such as cleanup costs, should prove simpler to demonstrate provided that good accounting records were kept during the remediation operation.

Several environmental statutes have adopted liability provisions that help reduce the costs of

[28] As of this writing, Exxon is preparing an appeal. "Long Shadow of the Exxon Valdez," *New York Times*, p. A22, Sept. 21, 1994.

making claims and administering the liability regime. For example, strict liability means that the proponent of a claim does not need to demonstrate the defendant entity was negligent, or failed to take adequate precautions. Some statutes spell out a method of calculating damages for which parties are liable, relieving the forum in which claims are made from having to develop such a methodology. Some require entities that admit to causing the pollution to establish private claims procedures, reducing or eliminating court or other costs of making a claim. And joint and several liability provisions —where all contributing parties are liable for the whole damage, not just for the portion they actually caused—relieve claimants from having to prove which of several entities caused what pollution. These and similar techniques may help to lower the costs of successfully bringing a claim.

Proponents of liability as an environmental policy tool stress that in theory liability systems can be administratively inexpensive to administer because they might rely on the existing court system, thereby avoiding the need for institution building. Furthermore, proponents argue that liability systems are administratively less expensive than other regulatory approaches where the probability of harmful emissions is low, since they need only come into play when damage occurs. Without damage, the only administrative costs of liability are those to add such provisions to a statute. It is unclear whether, on balance, the savings from having to deal with only those harms that occur outweigh the high costs of pursuing a claim.

Adaptability

A liability program is unlikely to require reformulation in the event of new technologies or scientific discoveries. The results of such a program may change, however. For example, scientific discoveries may give rise to new perceived harms and more claims. Or new scientific data might indicate that effects previously believed to be harmful do not in fact occur. Improved monitoring could expand the class of individuals exposed to previously undetected pollutants. And new pollution abatement technologies might change the standard of care an entity must meet to avoid liability, or to be protected by statutory strict liability caps.

Prolonged inflation or a change in economic circumstances might require a modification of the program's liability limits, if the compensation dollar amounts begin to look insignificant in light of potential profits from the polluting activity.

Information Reporting

Information reporting is a regulatory instrument that requires firms to provide specified types of information, either to a government agency or to the public directly. Required information typically involves activities affecting environmental quality, such as emissions, product characteristics, or ambient environmental data.

Information reporting programs fall into three basic categories: 1) required emissions reporting to the government for compliance and enforcement purposes; 2) reporting to the government to help both government and polluters better understand and respond to problems; and 3) informing the public of human health risks or environmental consequences posed by a firm's products or activities. These categories are not necessarily exclusive and in many cases a program designed to meet one of the objectives may also meet another. While information reporting for compliance and enforcement is common for environmental protection purposes, we are not focusing on it in this assessment. Instead, this analysis looks closely at information reporting for public use and for government and industry understanding of problems.

Information reporting for public use is based on the theory that disclosure of polluting activities by firms will raise public concern; it is then assumed that firms will change their behavior, when possible, to directly respond to the public's concern.

Although changes in pollution practices are not made mandatory by these right-to-know laws, firms face a variety of motivations to reduce pollution. These include the desire to be good neighbors and responsible corporate citizens, as well as

BOX 3-9: Debates About Liability

Assurance of Meeting Goals

Promotes criterion: Liability poses an incentive to reduce pollution, in order to avoid paying potentially large sums to injured parties.

Impairs criterion: Liability does not prohibit pollution by itself, but merely requires compensating those harmed, Establishing the degree of harm and chain of causation can be very complex, particularly if harm develops over many years.

Pollution Prevention

Promotes criterion: An entity has incentive to prevent pollution, because it maybe liable in the future even if in compliance with permit control requirements now.

Impairs criterion: Liability does not require pollution prevention.

Environmental Equity and Justice

Promotes criterion: Liability provides an opportunity for those who are harmed by emissions to seek compensation and cleanup of the problem.

Impairs criterion: Those harmed do not receive compensation unless they first expend resources to assert and prove a claim, which can be expensive and out of reach of many low-income people.

Cost-Effectiveness and Fairness to Sources

Promotes criterion: Liability is fair because entities are required to bear the costs of their emissions, even if those emissions are allowed under a permit.

Impairs criterion: Compensation occurs only after injured parties successfully establish claim for recovery, i.e., expend resources (which may or may not be available). A significant share of compensation may go to each party's lawyers and experts, rather than to those harmed. Strict liability can be unfair, because it need not acknowledge prior and ongoing pollution control activities.

Demands on Government

Promotes criterion: Liability programs might have low administrative costs, because they need come into play only when damage occurs.

Impairs criterion: Administrative resources needed to prove all elements of liability can be high. Determining the extent of damages can be very expensive, sometimes exceeding the cost of the damages themselves.

Adaptability

Promotes criterion: Sources are free to control pollution as they wish. Because liability can be retroactive, new scientific discoveries and priorities are readily accommodated.

Technology Innovation and Diffusion

Promotes criterion: Liability is probably neutral with regards to technology innovation.

Impairs criterion; Entities that develop innovative control and remediation equipment might curtail their activities, if they perceive themselves as a potential target for liability claims.

SOURCE: Office of Technology Assessment, 1995,

fear of adverse publicity or loss of sales. In addition, the public's heightened awareness of polluting activities due to information disclosure increases the possibility of regulatory agencies establishing stricter or more comprehensive regulatory requirements, another incentive for firms to pursue more proactive pollution reductions. For example, California's Air Toxics "Hot Spots" Information and Assessment Act set up a toxics reporting program that required facilities to identify potential health risks posed by emissions. The "Hot Spots" Act was amended five years after implementation. Instead of simply reporting risks, owners of "significant risk" facilities are now required to reduce the risk posed by toxics below the state-determined level of significance.

The appropriate form and extent of public information is part of an ongoing debate among those concerned with risk communication and the public's right to know. Some stakeholders, especially industry, are concerned with the public's perception of disclosed information, especially of raw emissions data such as pounds of pollutants per year. In these cases, the possibility for misunderstanding the actual risk related to exposure is high. However, translating emission data into possible impacts on human health and the environment increases the cost (burden) on industry. And as more kinds of information reporting are required, the risk of information overload is high. Too much information may dilute the intended impact on the public, either by confusing the important elements or by minimizing the impact of any warning because it simply becomes one of many.

Information reporting programs can be characterized by the method and extent of information dissemination. The more accessible the information, the more likely it is that the program will inform the public, raising awareness of environmental or health factors and possibly assisting in better decisionmaking. Some programs, such as the federal Toxics Release Inventory (TRI), require the government to actively distribute information, including access to the data in printed and computerized form. In contrast, in an earlier program, New Jersey's Community Right-to Know Act of 1984, industry emissions data is available to the public, but citizens are required to submit written requests in order to acquire the desired information.

Another aspect of information reporting is who should be responsible for its generation and distribution. Government agencies have long been involved in information collection and distribution. The value of the information for government and public use depends on how often the industries are required to submit emissions release information, the accuracy of the information, and the timeliness with which the data are made available.[29] Current programs vary as directed by regulation or legislative mandate, although reports are most frequently required annually. Regular reporting requirements are also useful over a given time period in order to better track changes.

Concern about trade secrets and confidentiality is another aspect of information reporting that influences the use and effectiveness of a program. Government agencies are sensitive to business concerns in these matters and try to include flexibility in some programs in order to diminish possible negative impacts from disclosure. However, the firm or industry is typically responsible for proving the need for confidentiality in reported data.

The effectiveness of information reporting programs is particularly difficult to evaluate due to the difficulties of isolating a firm's exact motivation for changing its polluting behavior. Typically,

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[29] The data made available through information reporting may support efforts to enact new legislation, develop pollution prevention and reduction strategies, and adopt new enforcement strategies. TRI data has also been found to help state agencies manage their own environmental programs. S.G. Hadden, *A Citizen's Right To Know: Risk Communication and Public Policy* (Boulder, CO: Westview Press, 1989); National Academy of Public Administration, *The Environment Goes to Market: The Implementation of Economic Incentives for Pollution Control* (Washington, DC: July 1994).

a firm's changed behavior is the result of many factors. The firm may need to comply with other environmental or health regulations. It may be anticipating new regulations. The firm may be responding to technology innovation or production engineering considerations. Though it may be difficult to find direct relationships between information reporting and firm behavior, the fear of negative publicity and threat of additional regulation probably encourage increased efforts to reduce risks associated with pollution (17).

Extent of Use

Information reporting programs—both those designed to inform the public and those designed to assist the government and industry in managing pollution—have become more common over the last 10 years. Until 1984 there was no public accounting of toxic chemicals used in facilities or discharged into air, water, and land. The first major efforts to require information reporting came on the heels of public reaction to the chemical accident in Bhopal, India. This disaster alerted many in the United States to the need to know more about the chemicals used and stored at facilities across the country.

Information reporting programs designed to alert the public to the risks of pollution are often referred to as community "right-to-know" laws. New Jersey's 1984 Community Right-to-Know Act was the first information reporting program in the country and served as the model for the national Toxics Release Inventory. Based on a survey conducted in the mid-1970s, it requires information on the use, storage, and discharge as waste of listed toxic chemicals.

The Emergency Planning and Community Right-To-Know Act (EPCRA), enacted as part of the 1986 Superfund Amendments, requires states to receive and disseminate information on hazardous chemicals present at facilities within local communities. Section 313 of EPCRA established the Toxics Release Inventory. TRI calls for owners or operators of certain manufacturing facilities to submit annual reports on the amounts of listed "toxic chemicals" released (routinely or accidentally) into the environment. Sections 311 and 312 of EPCRA require the owner/ operator of facilities with hazardous chemicals on site to report these chemicals to state and local agencies responsible for emergency response programs.

California's Safe Drinking Water and Toxic Enforcement Act, otherwise known as Proposition 65, is one of the better known state information reporting programs.[30] It is spelled out in two simple steps. First, it targets those chemicals "officially known to the state to cause cancer or reproductive toxicity" and requires they be identified and compiled in a list. Second, it requires that businesses should not knowingly and intentionally expose any individual to any one of the listed chemicals without first providing a clear and reasonable warning.[31]

These programs have been followed by increasing numbers of pollution prevention and toxics use reduction programs, which also incorporate reporting requirements to assist both government and industry understand and respond to potential problems. The programs include New Jersey's Pollution Prevention Act and California's Air Toxics "Hot Spots" Information and Assessment Act ("Hot Spots"). The Pollution Prevention Act requires firms to develop a publicly available five-year pollution prevention plan.

"Hot Spots" requires sources to collect emissions data and report it to the state. Sources that the state determines may cause localized impacts are required to ascertain potential health risks and inform nearby residents of these risks; "high-risk"

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[30] The law also requires that businesses should not discharge any listed toxic chemicals into any present or potential source of drinking water, but as this is not an information reporting program it is not addressed in this section.

[31] No warning is required if the amount of the listed chemical present in ambient environmental exposures, exposures from consumer product use, and discharges into current or future sources of drinking water fall below a level which would pose "no significant risk" for carcinogens.

facilities must prepare and implement risk-reduction planning within six months.

Key Criteria Affecting Tool Selection

Assurance of meeting goals

Information reporting provides less direct assurance than many other tools that goals will be met, because it does not mandate explicit pollution limits or place an explicit price on pollution. Instead, it relies solely on indirect incentives to achieve goals. Anecdotal information indicates that these incentives may have real power in particular situations where business profits are sensitive to public opinion.

A California EPA questionnaire attempting to determine the effects of Proposition 65 found that many businesses indicated that Proposition 65 was a factor in their own toxic emissions reductions. However, it was not clear to what extent these reductions were due to Proposition 65 as opposed to other laws and legal trends imposing liability for the use of toxics.

Information reporting programs may allow regulatory agencies to address risks which, although relatively easy to mitigate, are not on a scale to have been prioritized by other programs, For example, Proposition 65 has been used to eliminate lead in foil wrappings on wine bottles.

An information program designed primarily to alert firms and regulators to possible pollution problems may be slightly more effective at ensuring that environmental goals will be met. Pollution prevention plans and risk planning at least provide an "approved" framework for firms to make changes that will benefit the environment. For example, emissions data collected through "Hot Spots" has helped to more comprehensively manage toxic air contaminants in California by identifying localized risks and providing a basis for prioritizing further regulatory efforts.

Information programs can also be very important for highlighting environmental progress and successful strategies for pollution prevention or abatement. As such, information programs can help increase familiarity with particular tools used in combination with information programs.

Environmental equity and justice

Information reporting promotes environmental equity and justice, at least to a certain extent. The increased availability of information improves the opportunity for effective public participation. Theoretically, the information available under reporting programs can help citizens or regulatory agencies identify significantly affected populations. Citizens may be motivated by concerns about reported pollution levels or potential toxic chemical exposures and work for change by promoting additional regulatory controls, contacting or boycotting offending businesses, or pursuing enforcement actions.

However, there are few, if any, formal institutions or mechanisms for public participation within an information program alone. In addition, reporting programs do not address the issues of multiple exposures or toxic hot spots, nor do they do anything to remediate existing problems.

The type and accessibility of the information are important factors in determining the likelihood of its use. Public interest groups may also fill gaps in information interpretation and use. These groups often target particular problems and utilize available information through reports to widely publicize their concerns (210). A common complaint is that the "right to know" isn't necessarily "right to understand," so information is often uninterpreted raw data, and not necessarily linked to data about safe levels. More recent information reporting laws, such as California's "Hot Spots" and Proposition 65, have tried to address this confusion by requiring industry to report health risks rather than emissions data. However, this does increase the complexity of the program and the burden on industry.

In the end, while information programs may better equip citizens to work for greater protection of human health and environmental impacts, they may not go far enough. By providing only indirect incentives to polluters to improve environmental performance, actual results will be mixed. Some firms will make changes while others will not. Therefore, impacts on some communities may continue and be greater than in others.

Cost-effectiveness and fairness

An information reporting program is likely to be a less onerous form of regulation than direct requirements for pollution control. However, the burden on industry rises as more information is required of polluters—especially as the information demands increase beyond what is already required for compliance monitoring.

In theory, information reporting programs could improve the cost-effectiveness of risk management if they replace a current regulation at lower cost, or the efficiency if they correct a market failure not addressed by current regulations and the benefits of correction exceed the costs. In practice, the cost-effectiveness of information reporting programs is difficult to evaluate because it is almost impossible to clearly link a firm's changed behavior directly to reporting programs.

The cost-effectiveness of any reductions depends on how much information reporting changes the behavior of the reporting firms. If a high percentage of firms report, but very few of them change their behavior to reduce pollution, then the total cost-effectiveness is very poor. If polluting behavior changes, presumably it will be no less cost effective than if the same level of reduction was required. Since firms have complete flexibility in how they reduce emissions, it is possible that reductions from information reporting programs are more cost effective than those obtained from direct regulation. How much more cost effective is unknown, however.

When considering net benefits, one cannot simply assume that firms will control to a more efficient level. They may either overcontrol or undercontrol in comparison to environmental objectives. Because firms at least theoretically have an eye on the bottom line, the chance of significant overcontrol is probably modest, although some might include examples such as reformulating the correcting fluid Wite-Out, a measure often chalked up to Proposition 65, in this category (187).

Demands on government

The burden information reporting places on government depends on the type of program and the level of responsibility assumed by the implementing agency. Government roles vary widely among information reporting programs. Their responsibilities may include the following: information collection; information management; data interpretation and analysis; information dissemination; and enforcement. The more labor intensive the government role is, the greater the demand will be on agency resources and expertise.

Comparing administrative costs associated with information reporting programs is not particularly instructive since program characteristics vary widely. California's Proposition 65, one example of an information reporting program, involves relatively minimal responsibility for the implementing agency (271). By law, the state agency helps to manage the list of chemicals used for reporting purposes, provides some technical guidance, and pursues enforcement activities. There is no central collection or dissemination of information in the program. Instead, Proposition 65 shifts the burden of proof from government to producers or sellers to show that their activities do not exceed the "no significant risk" level.[32] Under typical regulatory approaches, the law is not in force until the government determines how much is too much; therefore, the regulated entities have no incentive to assist the government in drawing this line.

[32] For carcinogens, California has established that threshold at the level that would produce one excess cancer per 100,000 humans exposed over a 70-year lifetime at that level. For chemicals with possible reproductive effects, regulations require there is less than a 1/1000 chance of exceeding the "no observable effect" level (NOEL).

In contrast, warning labels are required under Proposition 65 unless a company proves that the amount it emits is not a significant risk. Thus it is in industry's interest to have clarity and certainty when it comes to setting acceptable levels for chemicals, so that companies know how to comply—and once such levels are set, they are generally accepted. Possibly as a result of industry assistance, California's regulators defined risk levels for more chemicals in the first 12 months than EPA has managed to address under the federal Toxic Substances Control Act (TSCA) in the past 12 years (158).

The limited nature of government intervention in Proposition 65 is somewhat unique. New Jersey's Community Right-to-Know Act of 1984 requires substantial government activity including data collection, information management, data analysis, and public disclosure.

Adaptability

Information reporting programs are likely to be capable of adapting to change. When new scientific information or technological developments occur, sources are free to modify their operations or not, as they choose.

Changing the program itself is somewhat more difficult, but probably not as difficult as changing many other types of policy instruments. Recent discussions on proposals for changing the Toxics Release Inventory highlighted several major issues.[33] Overall, industry is primarily concerned with confidentiality and the added burden of collecting more information. The EPA expressed concerns about additional costs associated with data entry and the need to modify the current database to facilitate new data points. Although the industry's increasing interest for electronic reporting addresses some of the problems with data entry, EPA accrued significant costs gearing up their program and equipment to accept electronic data. Though issues such as these could be resolved, they are nonetheless factors which influence adaptability to change.

Subsidies

Subsidies are policy instruments that provide various forms of financial assistance, which can act as an incentive for entities to change their behavior or help entities having difficulty complying with imposed standards. Subsidies are the inverse of pollution charges: instead of an entity paying a fee for polluting behavior, the entity is given funds to engage in environmentally beneficial behavior. Subsidies might be provided by the government or by other parties. In essence, subsidies provide the means for the government or other parties to bear part of the cost to stimulate adoption of new or proven environmentally beneficial controls or behavior.

Subsidies can come in many forms: grants, low- or no-interest loans, preferential tax treatment, and deposit-refund systems. Note, however, that the recipients of such largess are generally not free to spend it in accordance with their own priorities. Prospective grantees and borrowers must fit their requests to stringent government procurement regulations, and recipients must comply with fairly detailed requirements governing how the money must be spent. Similarly, entities taking advantage of available tax breaks must be prepared to demonstrate in detail how the claimed expenditures come within the eligibility criteria. Deposit-refund systems require the article to be properly returned before a refund is given.

The use of subsidies historically has been affected by the "polluter pays" principle, which says that entities should be responsible financially for cleaning up the pollution they cause. Subsidies run counter to this principle. As a result, many public grant programs have subsidized public facilities' pollution control efforts, such as publicly owned wastewater treatment plants, but left pri-

[33] Proposed changes have included: requiring materials accounting data; expanding the chemical list; expanding the number of regulated industries; and requiring peak emissions data.

BOX 3-10: Debates About Information Reporting

Assurance of Meeting Goals

Promotes criterion: Information reporting helps to determine progress and goal achievement, and can encourage otherwise unregulated sources to lower emissions.

Impairs criterion: Because information reporting does not require a level of pollution abatement, it provides little assurance goals will be met (unless combined with other tools).

Pollution Prevention

Promotes criterion: Product warning labels may encourage industries to reformulate.

Impairs criterion: Information reporting does not guarantee that reductions will be made; if made, they might be accomplished with additional control equipment.

Environmental Equity and Justice

*Promotes criterion:*More easily available information may encourage public participation in matters affecting human health and environmental protection. Information programs can promote greater awareness of the risks posed by pollutants.

*Impairs criterion:*Information reporting programs provide no guarantee that communities will receive any additional protection from pollutants.

Cost-Effectiveness and Fairness to Sources

Promotes criterion; If reductions are made, industry has complete flexibility in deciding how to do so. Industry considers information reporting programs less intrusive than tools with fixed pollution control requirements.

Impairs criterion: Information generation may be very time- and labor-intensive, especially for smaller firms.

Demands on Government

Promotes criterion: Typically, demands on government are comparatively light.

Impairs criterion: Collection and distribution of information can bean additional burden for government.

Adaptability

Promotes criterion: Sources are free to control as they wish. If an agency requires new information, it can request it relatively easily.

Technology Innovation and Diffusion

Information reporting programs are probably neutral with regards to technology innovation,

SOURCE: Office of Technology Assessment, 1995.

vate sources of pollution largely on their own. Justifications for this differential treatment tend to focus on the public nature of pollution from public sources, arguably appropriate candidates for the use of public funds. Also, public sources generally are not operating to make a profit, unlike private facilities which at least in theory could consider pollution control as part of the cost of doing business. Note that this public-private treatment is hardly absolute. For example, states are authorized to use Clean Water Act federal grants to help farmers pay for the cost of best management practices (BMPs) to control polluted runoff.

In contrast to grants, tax breaks tend to be almost exclusively aimed at private sources of pollution.[34] Deposit-refund programs affect whoever purchases and returns the items covered by the program.

Extent of Use

Subsidies are very widely used as a tool to promote environmentally beneficial behavior. The examples below are illustrative, and by no means exhaustive, of the various federal, state, and local subsidy programs. Subsidies may also be provided by private parties, although such programs are less common.

One of the largest public works program in history was accomplished through subsidies, the Clean Water Act's construction grant program. Congress established the program in recognition that localities would need to spend large sums of money to comply with Clean Water Act regulatory requirements. Construction grants were made available for the building of publicly owned wastewater treatment works. From inception in 1972 through 1994, over 60 billion federal dollars were spent. Grant recipients were initially required to match federal funds with 25 percent, increasing to 45 percent in 1981.

The construction grant program was phased out by the 1987 Amendments to the Clean Water Act, and replaced with a state revolving loan fund (SRF). Currently, the Act provides federal capitalization grants to SRFs—seed money—that provide state loans to localities for constructing publicly owned wastewater treatment plants, implementing nonpoint source management plans, or developing and implementing a national estuary program (247). Within those general statutory guidelines, a state is free to structure its specific programs in the way that it determines best pursues the goal of clean water. Some states, such as New York, provide "negative interest" loans to financially strapped small communities (effectively, a grant coupled with a loan). The Act authorized between $1.2 billion and $2.4 billion for each of five years; since 1989, $7.8 billion has been appropriated. States must provide a minimum of 20 percent matching funds to establish the SRF.

The Clean Air Act also authorizes several grant programs. For example, section 105 grants EPA the authority to award grants to state and local governments to develop and implement air pollution control programs. Since 1963, the federal government has awarded states and localities over $2 billion in air pollution control grants. EPA may pay up to 60 percent of grant costs, but states must provide the remaining 40 percent (214).

Grants and low- or no-interest loans are used in other contexts, as well. For example, EPA operates a small grant program called Pollution Prevention Incentives for States (PPIS), which has awarded over $23 million since 1989 to promote pollution prevention activities (107). EPA also provided grants to six universities, totaling over $330,000 in 1992, for research on alternative chemical manufacturing methods that would reduce the generation of waste while increasing productivity. The grants were part of Design for Environment (DFE), a voluntary program to promote the use of safer chemicals, processes, and technologies in the earliest design stages (67).

States also use grants and low- or no-interest loans to promote environmentally beneficial behavior. For example, Wisconsin provides cost-share grants for up to 70 percent of the costs for corrective measures necessary to clean up agricultural runoff, a type of nonpoint source water pollution. Project grants average about $15,000 and usually are accompanied by technical assistance provided by county-based conservation technicians (138).

Tax breaks and other preferential tax treatment have also been used to accomplish environmental goals. For example, for many years private com-

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[34] One potential exception is the tax-free nature of interest from state and municipal bonds, which can—but need not necessarily—be for building public pollution control facilities.

panies were allowed to take accelerated depreciation of investments aimed at reducing water pollution (58). Under the tax law in effect from 1979 to 1985, employer-provided transportation—vanpools—between an employee's residence and place of work was not considered taxable compensation. Thus an employer could provide a greater net benefit to employees if it set up vanpools.[35]

States are also using the tax code to promote environmentally beneficial behavior. For example, in December 1990, Louisiana enacted a new tax rule that ties the amount of business property taxes a firm pays to its environmental record. For almost 70 years, Louisiana has exempted new equipment and capital expenditures from local property taxes, as a way to encourage industry to locate in the state. Under the new rule, a firm applying for an exemption or seeking a renewal of an exemption from property tax was rated on a scale according to the number of environmental violations it had received, the volume of chemicals it released into the environment, and similar factors. Firms with good records received higher scores and a larger tax exemption. The program was terminated by Governor Edwards in 1992 (64,79, 203).

Deposit-refund programs are another example of subsidies. On a small scale, deposit-refund systems have been in place for decades in grocery stores, where customers or others who returned empty soda containers were refunded a small deposit paid when the soda was purchased. Currently, at least nine states have enacted deposit-refund programs—"bottle bills"—to reduce littering with beverage containers.[36] In effect, purchasers of potentially polluting waste pay a surcharge which is paid to whoever returns the container for recycling or proper disposal. Thus the subsidy is represented by the refund. Rhode Island and Maine have adopted deposit-refund systems for automobile batteries, and Maine has a system for commercial-sized pesticide containers (184).

Key Criteria Affecting Tool Selection

Assurance of meeting goals

Subsidies are capable of achieving risk-based and abatement goals to the extent that the government or others are willing to pay to achieve those goals. However, subsidies do not require a particular level of pollution control, because targeted entities can refuse the subsidy and associated obligations.

When the government pays for abatement and requires as a condition of payment proof that the desired action has been taken, officials know that emission reductions will almost certainly take place. Private firms and local governments are generally willing to install pollution control technologies if somebody else will pay for it. If the subsidy is not for the full amount of the pollution control device, private companies and localities may still be willing to invest in pollution control technology, but they must perceive some benefit to them from the investment.

Tax breaks can reduce the cost of compliance with environmental requirements. Like pollution charges, they can be "tuned" through a process of trial and error to achieve pollution reduction goals. Since they can be tied to a preexisting enforcement regime, tax incentives may be easier to enforce. In practice, however, tax breaks are often too small to inspire a company to install a technology that it would not otherwise have considered (123,165). A tax break may be altogether meaningless to a company that is operating at a loss. Still, if tax breaks can be used to offset expenditures on technologies that both increase plant efficiency and reduce pollution, they may offer a

[35] All that is left now is a general purpose tax provision that renders *de minimus* fringe benefits nontaxable. Employee-provided public transit passes often come under this provision. S. Gaines and R. Westin, *Taxation for Environmental Protection: A Multinational Legal Study* (New York, NY: Quorum Books, 1991)

[36] These states are, in order of adoption: Oregon, Vermont, Maine, Michigan, Iowa, Connecticut, Delaware, Massachusetts, and New York.

significant incentive to invest in such technologies.

One problem with subsidies is that they typically are for capital costs, not operating and maintenance expenses. Some economists and others have theorized that end-of-the-pipe technologies paid for by the government will not be operated effectively if the government does not assume responsibility for some portion of the operating costs (58,123).

A second potential problem with subsidies is their effect on industry turnover. By making marginal firms more profitable, subsidies might even encourage new entrants into the polluting industry or discourage old ones from leaving, thereby causing larger aggregate emissions than there otherwise might be.

Environmental equity and justice

Subsidies can be used to promote environmental justice because they can be targeted to specific pollution sources affecting poor or minority neighborhoods. Subsidies can also have a progressive income effect. For example, construction grants for publicly owned wastewater treatment works shifted much of the burden of complying with the Clean Water Act from individual communities to the national tax base. Thus, sewage treatment became available to communities that otherwise would have faced great difficulty raising sufficient funds.

Unless targeted specifically for community outreach and activism, subsidies appear to have little effect on communities' abilities to affect policy outcomes. Most individual subsidy grants are not subject to notice-and-comment rulemaking, and so do not offer an opportunity for community concerns to be heard.

Subsidies can help remediation of existing environmental problem because they can provide a revenue source for necessary clean-up procedures.

Demands on government

If the subsidy is funded by tax dollars, obviously direct outlays by government can be high. If the program is funded by other means, analytical demands are probably average or somewhat lower than other types of policy instruments.

Some organization needs to determine which entities are selected or entitled to receive a subsidy and to ensure that actions for which the subsidy is paid have in fact occurred. In the case of deposit-refund subsidies, these functions are easy—pay whoever walked in with the refundable item.

Ensuring under other types of subsidies that required actions are taken is somewhat more complicated. Government organizations that make grants or loans to industrial entities could monitor the funds' use to ensure that they are expended upon pollution controls and not on reducing manufacturing costs generally (7,123).[37] Alternatively, the government could make payment of subsidies contingent on the recipient proving it has undertaken the desired pollution prevention or abatement action, thereby reducing government resource requirements for monitoring and enforcement.

Technical Assistance

The government offers technical assistance to help target entities in a number of ways. Entities might not be knowledgeable about whether existing regulations apply to them, be fully aware of the environmental consequences of their actions, or know what techniques or equipment reduce those consequences. Government technical assistance programs are intended to educate entities to make better environmental choices. Technical assistance may also be focused on the general public, to help educate them about the environmental implications of existing programs, proposed rules, and policy tradeoffs.

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[37] For example, firms might exaggerate baseline pollution levels in order to maximize their subsidies.

BOX 3-11: Debates About Subsidies

Assurance of Meeting Goals

Promotes criterion: Full subsidies are capable of achieving environmental goals to the extent that those funding the subsidies are willing to pay.

*Impairs criterion:*Subsidies when used alone do not require a particular level of pollutant abatement, They can encourage new businesses to open and old ones to remain, thereby increasing aggregate emissions.

Pollution Prevention

Promotes criterion: Subsidies can be awarded expressly for pollution prevention,

*Impairs criterion:*Preferential tax treatment or other subsidies can be awarded for end-of-the-pipe control, which can discourage pollution prevention.

Environmental Equity and Justice

Promotes criterion: Subsidies can promote environmental justice, by being targeted to specific pollution sources affecting poor or minority neighborhoods.

Cost-Effectiveness and Fairness to Sources

*Promotes criterion:*Subsidies can be used to compensate for unfairness caused by regulatory programs.

Impairs criterion: Subsidies' purposes are sometimes stated so specifically that they can lead to choices that are not cost effective for society. They can create financial inequities among entities.

Demands on Government

Impairs criterion: Government subsidies cost money.

Adaptability

Promotes criterion: Subsidies can have enough flexibility to adapt to new science or technology.

Impairs criterion: The scope of many subsidies' mandates is so narrow that rulemaking or legislation is required to accommodate new science or technology.

Technology innovation and Diffusion

Promotes criterion: Subsidies can help diffuse new technologies.

Impairs criterion: There is little or no data to prove subsidies cause innovation,

SOURCE Office of Technology Assessment. 1995,

Technical assistance may take many forms, ineluding manuals and guidance, training programs and materials, information clearinghouses, facility evaluations, and technology R&D. The latter may be conducted in house or through grants or loans to regulated entities or universities. Many junctions of environmental agencies can be called technical assistance. For example, the Oregon Department of Environmental Quality (DEQ) identified 35 separate programs as providing technical assistance, noting that technical assistance played a large role in day-to-day environmental management activities.[38] Most technical assistance services are provided at no cost to the user. Yet sometimes technical assistance is offered in exchange for a prior agreement from the facility to implement any recommendations. For example, in the federal Green Lights program, EPA performs an onsite evaluation to identify ways in which a facility could reduce energy consumption, in exchange for a promise from the facility to install recommended equipment.

Participation in technical assistance programs typically is voluntary, not mandatory. However, these programs often offer significant incentives to participate. Such incentives include the benefits of the knowledge or services provided, favorable public relations, and perhaps, a positive working relationship with a regulatory agency.

Extent of Use

Before the 1970s, the federal government's primary environmental role was to provide technical assistance to states and private firms, offering them the benefit of federal agency expertise in solving what were viewed as largely local problems. While the federal government's role grew dramatically in the intervening years, with the passage of major environmental legislation, it still performs an important technical assistance function. In the 1990s these technical assistance programs are increasing both in number and variety.

Some technical assistance programs have been developed in response to congressional mandates, while others have been initiated by EPA and other agencies.

An example of a congressionally mandated technical assistance programs is the section 507 program established by the Clean Air Act Amendments of 1990 (239). The Act requires states to establish Small Business Stationary Source Technical and Environmental Compliance Assistance Programs. These Section 507 programs are targeted particularly at those small businesses that are newly subject to regulation, are non-major sources as defined under the Clean Air Act, and which might otherwise lack the technical expertise and financial resources to evaluate regulatory requirements and determine appropriate compliance approaches (202). The programs include onsite auditing, information packets, information clearinghouses, and other forms of technical assistance.

Similarly, CERCLA establishes the Technical Assistance Grants (TAG) Program. TAGs are intended to assist the affected community at Superfund sites to understand and evaluate problems posed and to help assure cleanup methods were chosen appropriately. "[A]ny group of individuals which may be affected by a release or threatened release" is eligible for a TAG.[39]

Some technical assistance initiatives are intended to help implement mandated environmental programs. For example, section 319 of the Clean Water Act calls for states to manage diffuse nonpoint sources of water pollution. EPA and the U.S. Department of Agriculture have developed extensive guidance documents describing BMPs that nonpoint sources might use to control their pollution. Both federal and state agencies distribute this guidance widely and also have sponsored a series of field evaluations.

Other technical assistance programs do not respond directly to statutory mandates, but are derived from the general objective to improve environmental quality. A recent example of federal technical assistance is EPA's Green Lights Program. EPA conducts an energy audit of participat-

[38] DEQ concluded that two-thirds of the programs were compliance oriented, while the remaining one-third focused on pollution prevention. The amount of assistance ranged from comprehensive technical help, including on-site evaluations, to more limited technical assistance such as telephone hotlines. DEQ's technical assistance programs cover a wide variety of audiences, including the general public; federal, state, and local government agencies; schools; and regulated and nonregulated businesses. Oregon Department of Environmental Quality, *Enhancing Technical Assistance and Pollution Prevention Initiatives at the Oregon Department of Environmental Quality,* (Salem, OR: April 1994).

[39] A TAG may not exceed $50,000 per grant recipient unless the President finds that the purposes of the program require the limit to be waived. CERCLA § 117, 42 U.S.C. § 9617.

ing Green Lights Partners, and makes specific recommendations for more energy-efficient lighting systems, in exchange for an agreement from participants to install the recommended equipment.[40] Participants receive the benefit of an energy audit and lower utility bills, favorable publicity, and a cooperative working relationship with a regulatory agency (41,68).

A similar EPA program, Water Alliance for Voluntary Efficiency (WAVE), is designed to encourage participants to install water-efficient fixtures in exchange for an EPA audit of their facilities. A number of similar programs have sprung up in recent years and are receiving additional attention in the wake of Vice President Gore's reinventing government initiative. They include the "energy star" program aimed at encouraging the development of energy-efficient products such as green computers and super-efficient refrigerators, and Wastewi$e and Climate-Wise, which provide technical assistance for reductions in, respectively, solid waste and greenhouse gasses. Such programs are often supported by hotlines, information packets, and onsite evaluations.

Hotlines are a form of technical assistance heavily used for both mandated and discretionary federal environmental programs. Hotlines generally provide free technical assistance to both the regulated community and the public, usually either by providing information directly over the telephone or by mailing requested materials. Examples of EPA hotlines functioning in late 1994 include—

- the Control Technology Center (CTC) Hotline providing technical support and guidance concerning air emissions control technologies;
- Emergency Planning and Community Right-To-Know and Superfund Hotline, providing regulatory, policy, and technical assistance to government agencies, the public, and the regulated community;
- Pollution Prevention Information Clearinghouse, providing pollution prevention information to the public; and
- the Safe Drinking Water Hotline, providing assistance and information to the regulated community and the public.[41]

State governments have been very active in developing technical assistance programs, especially for pollution prevention. In fact, until recently states have relied almost exclusively on technical assistance as the instrument for pollution prevention. The size of state technical assistance programs varies widely.[42] Since the late 1980s, EPA appropriations have included special grants funds for Pollution Prevention Incentives For States (PPIS) grants, which offer a 50-percent federal match for state assistance program funding (195).[43]

Key Criteria Affecting Tool Selection

Assurance of meeting goals

Technical assistance programs do not require target entities to control their emissions. Instead, these programs seek to achieve environmental goals by increasing the understanding of pollution

[40] Green Lights Partners must also submit an annual reporting form, specifying the number of fixtures, wattage per fixture, the number of kilowatt hours, and other energy-related data. M. Arnold, Green Lights Program, U.S. Environmental Protection Agency, Washington, DC, personal communication, Dec. 15, 1994.

[41] For a complete list, see U.S. Environmental Protection Agency, *Headquarters Telephone Directory*, EPA 208-B-94-001 (Washington, DC: August 1994).

[42] Nationwide, the programs average three to four staff people although some are considerably larger. For instance, Massachusetts' Office of Technical Assistance and North Carolina's Pollution Prevention Program each have about 30 staff.

[43] The Pollution Prevention Act of 1991 authorized $8 million per year in grants. Between 1989 and 1993, about $20 million in PPIS grants was awarded by EPA.

problems and potential solutions. Assistance can always be rejected, and likely will be if the solutions identified are expensive or if the promised paybacks do not fit with a particular firm's economic horizon. Anecdotal and evaluative data indicate that technical assistance programs improve environmental quality (129).

Available data are less clear about whether environmental goals are in fact achieved. Technical assistance programs are often used in combination with other environmental policy tools.

Pollution prevention

Technical assistance has a 10-year history as an instrument for pollution prevention. There is a growing body of anecdotal evidence that when the government provides onsite evaluations, increased use of pollution prevention is more likely (55).

What is less clear, however, is whether technical assistance alone can realize the goals of the Pollution Prevention Act of 1991. States have been the leaders in using technical assistance for pollution prevention. Many are now moving toward more prescriptive means, integrating pollution prevention into regulations and requiring facility planning. As a result, technical assistance is becoming less of a stand-alone instrument and being used more in combination with others to achieve pollution prevention goals.

Environmental equity and justice

Some forms of technical assistance can help poor and minority groups have meaningful input in the public notice and comment rulemaking procedures. Often, proposed rules have very technical and complex foundations that are difficult for nonspecialists to evaluate and comment upon. Technical assistance targeted at such groups could highlight a proposal's implications, and help groups better understand and comment on the underlying issues. For instance, CERCLA Section 117 authorizes EPA to make technical assistance grants to any group of individuals affected by a Superfund site (249). The grant enables citizen groups concerned about a particular Superfund cleanup site to hire technical expertise to help them understand the issues and evaluate alternative cleanup proposals.

Technical assistance to regulated entities would only indirectly pursue environmental justice goals because it does not call for a particular level of pollution abatement. However, technical assistance might assist in remediation of existing pollution problems, if those responsible for cleanup are uncertain as to the most effective and timely remediation techniques.

Cost-effectiveness and fairness

Technical assistance programs can help attain least-cost pollution reductions if they are targeted at the appropriate entities and are at an appropriate intensity. Firms operate with limited information concerning the nature and impact of their emissions and the approaches which they might take to reduce emissions. Technical assistance can help reduce these information gaps that otherwise might impair achievement of cost-effective pollution control.

However, to help attain a least-cost solution, technical assistance must be at an appropriate intensity and targeted at groups with significant information gaps. Information and its dissemination are not costless. If technical assistance programs focus on onsite evaluations when informational brochures would have as effectively educated the target audience, the program does not attain environmental goals cost effectively. Similarly, a technical assistance program would not be cost effective if most participants in technical assistance programs are those entities who are already well informed and with other sources of necessary information. Cost-effectiveness is ultimately determined by how well the resources devoted to technical assistance motivate positive changes in the environment.

Data on the cost-effectiveness of technical assistance programs are not extensive, in part be-

BOX 3-12: Debates About Technical Assistance

Assurance of Meeting Goals

Promotes *criterion:* When combined with other instruments, technical assistance can lead to improved environmental quality.

Impairs criterion: Technical assistance does not require reduction in pollution

Pollution Prevention

Promotes criterion: Technical assistance can help firms identify opportunities for pollution prevention, and change attitudes towards pollution prevention.

Impairs criterion: Technical assistance alone might not be enough to achieve pollution prevention goals, but may be better used in combination with other instruments.

Environmental Equity and Justice

Promotes criterion: Technical assistance to communities can help to increase public awareness of the environmental implications of existing programs and proposed rules.

Cost-Effectiveness and Fairness to Sources

Promotes criterion: Technical assistance can help reduce information gaps which otherwise impair achievement of cost-effective control.

Impairs criterion: While technical assistance can result in savings to the target entities, it mayor may not be cost effective for society.

Demands on Government

Impairs criterion: Technical assistance is a resource commitment by government.

Adaptability

Promotes criterion: Technical assistance can accommodate new scientific or engineering information, without structural programmatic changes.

Technology Innovation and Diffusion

Promotes criterion: Technical assistance diffuses knowledge of pollution control technologies.

Impairs criterion: Technical assistance does little if anything to foster technology Innovation.

SOURCE, Off Ice of Technology Assessment, 1995

cause it is often difficult to attribute observed environmental progress to a particular technical assistance program. Data does exist, however, that indicate cost savings to firms from onsite technical assistance exceed the cost of providing the assistance. This was the case, for example, for the Massachusetts Office of Technical Assistance (MassOTA), discussed in chapter 2 of this assessment.

Adaptability

Technical assistance programs, compared to other instruments, are easily modified in light of a change in scientific knowledge, abatement capability, or budget. The modifications might be to the information disseminated by the program or to the structure of the program itself, depending on the nature of the change.

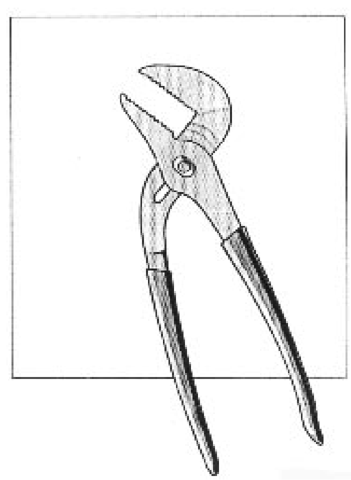
Choosing Policy Tools: Seven Important Criteria 4

INTRODUCTION

Although the nation's near-term commitment to a cleaner environment is evident in the strong goals Congress has established, considerable controversy exists about how best to achieve these and future goals. For example, policymakers would ideally want to choose policy instruments that move the nation toward a cleaner environment at the lowest possible cost while accommodating, and further encouraging, the increasingly rapid changes in scientific and technological capabilities. Yet accomplishing all of this with the tools we have has seldom been possible in the past and may be even more difficult in the future.

One potential strategy for minimizing tradeoffs among these strongly held, yet at times competing, values and interests is to choose policy instruments according to their strengths and to use additional instruments to shore up overall performance. In the past, for example, the nation has relied heavily on harm-based standards and design standards because we would be able to tell on a source-by-source basis the progress being made in cleaning up the environment. However, by emphasizing assurance of meeting goals, in many instances we chose—implicitly or explicitly—to give up some of the potential for cost savings and technology innovation.

Rather than discard harm-based or design standards, policymakers can combine them with other approaches, such as trading programs or challenge regulations. These combinations offer firms more flexibility to choose the means or timing of compliance, allowing the implementation of more cost-effective solutions for individual firms with relatively little loss of the assurance the public wants. However, the use of trading programs



or challenge regulations may raise concerns that, even though overall environmental quality improves, the burden of remaining adverse environmental effects will be shifted from one group to another. Careful monitoring and required information reporting can address some of those concerns.

This chapter examines how knowledge about differences in instrument performance on a set of values and interests—called **criteria** in this report—might guide a policymaker's choices. The next section identifies each of the criteria used in this study. The following sections define the criteria in more detail and compare the relative effectiveness of the policy instruments described in chapter 3 for achieving each criterion.

IMPORTANT CRITERIA FOR ENVIRONMENTAL POLICY

OTA has identified three broad themes in the debate over environmental policy. The first theme, **environmental results**, addresses the public's demand not only that goals be met but also that goals be pursued in appropriate ways. The second theme, **costs and burdens**, addresses the public's concern that environmental goals be achieved at the lowest possible costs and with the fairest allocation of burdens among companies and between government and industry. And the last theme, **change,** reflects a growing consensus that adaptable programs are essential for encouraging new scientific and technological solutions.

Sharpening the focus to the details underlying these broad themes, OTA identified seven criteria policymakers typically consider when adopting specific programs to implement environmental initiatives (see table 4-1). We use each of these seven criteria as the basis for comparing the relative effectiveness of the policy instruments, based on literature reviews and actual experience with using the instruments.

Although lack of sufficient experience with many of the instruments made us less certain about how they might perform in some instances, we found that assessing instrument choice from the perspective of this set of criteria revealed distinctive and useful guidelines for policymakers.

Our rating system identifies those instruments that are particularly **effective** (represented by a filled-in circle), those for which **it depends** (represented by a partially filled-in circle), those that we suggest a decisionmaker might **use with caution** (represented by a caution sign), and those that are simply **average** (represented by a single dot). An effective instrument is considered reliable to use if the criterion is an important one. An instrument rated "it depends" is likely to be effective but could in some instances be simply average. And instruments that might be used with caution typically perform poorly on the criteria.

The remainder of this chapter is organized around the three themes and seven criteria presented in table 4-1. After a brief section introducing one of the three themes, we compare instrument effectiveness on each of the criteria associated with that theme. For each criterion, information is presented in the following order:

- discussion of the criterion;
- explanation of the factors used for comparing instruments;
- overview of instrument performance; and
- an instrument-by-instrument analysis, starting with the most effective ones, followed by those rated "it depends," then those requiring some caution, and concluding with those expected to be about average.

ENVIRONMENTAL RESULTS

Congress sometimes chooses voluntary approaches for accomplishing environmental goals and at other times requires specific actions to improve human health and the environment in some way. Yet even when Congress has required specific actions, the nation has often fallen short of achieving the goal (47). Thus, for many stakeholders in the environmental policy community, the most important priority continues to be working toward satisfactory **environmental results**.

When it comes to very serious environmental risks, the public is likely to want **assurance** that

TABLE 4-1: Criteria And Factors Used For Comparing Instruments

CRITERIA	FACTORS
ENVIRONMENTAL RESULTS	
Assurance of Meeting Goals Do stakeholders have confidence that environmental goals will be or have been met?	• Action forcing • Monitoring capability • Familiarity with use
Pollution Prevention Can the approach promote use of strategies for preventing rather than controlling pollution?	• Gives prevention an advantage • Focuses on learning
Environmental Equity and Justice Does the approach seek equality of outcomes, full participation by affected communities in decision-making, and freedom from bias in policy implementation?	• Distributional outcomes • Effective participation • Remediation
COSTS AND BURDENS	
Cost-Effectiveness and Fairness Are we protecting human health and the environment at the lowest possible cost and with the fairest allocation of burdens for sources?	• Cost-effectiveness for society • Cost-effectiveness for sources • Fairness to sources • Administrative burden for sources
Demands on Government Are we protecting human health and the environment at the lowest possible cost and with the best use of resources for government?	• costs • Ease of analysis
CHANGE	
Adaptability How easily can the approach be adapted to new scientific information or abatement capability?	• Ease of program modification • Ease of change for sources
Technology Innovation and Diffusion Are we encouraging new ways to achieve our environmental goals that lead to improved performance in quality and costs?	• Innovation in the regulated industries • Innovation in the EG&S industry • Diffusion of known technologies

SOURCE: Office of Technology Assessment, 1995.

goals will be met. In addition, the public has also become concerned about *how* goals are met. For example, support has increased for the idea that sources should be asked to try their best to use pollution prevention rather than control. And, community-based groups have been highly successful in raising awareness about environmental equity and justice concerns at all levels of policy-making.

The following three sections of this chapter—assurance of meeting goals, pollution prevention, and environmental equity and justice—present OTA'S assessment of which instruments might be most effective in achieving these criteria.

Assurance of Meeting Environmental Goals[1]

Assurance is stakeholder confidence that environmental goals have been or will be met.

Assurance of meeting the goal may be the bottom line criterion for many stakeholders, especially when the environmental problem poses serious risks to human health. In recent years, for example, community scrutiny of facilities using toxic or hazardous substances has increased, including efforts to block siting. In such a context, choosing policies that provide assurance of achieving the desired results may seem more important than satisfying criteria that might otherwise be favored.

At the national level, reports assessing progress toward protecting human health and the environment indicate that we are still far short of our goals (47). When it seems essential to meet public expectations that progress toward goals will occur in the future, requiring specific actions and establishing effective monitoring programs may be an important approach. Using instruments that have been implemented with some successful results in the past may also enhance public confidence in policy decisions.

Factors for Comparing Instruments

As defined in this OTA study, assurance means the confidence stakeholders have that environmental goals have been or will be met and sources held accountable for the results. Determining that environmental goals have been met requires the ability to monitor results and to force action should the results fall short of the goals. In addition, if an instrument has been extensively used or implemented in the past with successful results, the public may have confidence that the instrument will be effective in meeting future goals.

In order to compare how well each instrument assures meeting environmental goals, OTA uses the following three components:

- action forcing;
- monitoring capability; and
- familiarity with use.

Degree of action forcing

Central to the concept of assurance is the extent to which an instrument has "teeth" or the capacity to force sources to undertake actions needed to attain environmental goals. Action-forcing instruments specify pollution reduction results and provide a means for holding sources accountable. The relative importance of action forcing for a stakeholder may depend in large part on his or her assessment of what drives the behavior of sources or targeted industries. Some believe that if industry is provided a clear goal or target of pollution reduction and a reasonable timetable for action, a forcing action or level is not necessary for goal attainment. However, others believe that only those instruments that contain a lever for forcing action provide sufficient pressure and accountability to assure that individuals, facilities, or firms will have to change their behavior until the goal has been met.

Monitoring capability

Monitoring capability has two components: 1) having the capacity to determine whether or not the source is doing what is required, and 2) having the capacity to determine whether or not progress is being made toward the overall environmental goal. The strategy underlying this instrument may affect how easy or difficult it will be to monitor for results. For example, a technology-based strategy based on percent reductions in emissions or a best available technology is inherently easier to monitor than a risk-based strategy designating an ambi-

[1] Parts of this section are based on T.O. McGarity, "Assurance of Meeting Environmental Goals," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, May 1994.

ent environmental quality goal across multiple sources. Instrument performance that is relatively easy to monitor increases the opportunities for eventual accountability, enforcement, and evaluation of instrument effectiveness.

The availability of adequate monitoring technologies and the type of monitoring regime used may also affect a stakeholder's sense of assurance. For example, continuous monitoring may be considered by some to be essential for individual sources even though systematic, yet less sophisticated and less frequent, monitoring may be satisfactory for others.

Familiarity through use

If an instrument has been used with any success in the past, policymakers may have more confidence in using it in the future. In fact, some instruments may be heavily used primarily because policymakers already know how to implement them and existing institutional arrangements make it easy to continue using them. Especially for problems that have very serious short-term consequences, the public may want policymakers to use instruments that are tried and true even though they may not achieve all or even any of the other major criteria.

Summary of Instrument Performance

- ● **Effective:** ***Product bans, technology specifications, design standards, harm-based standards, integrated permitting***
- ○ **It depends:** ***Tradeable emissions***
- ▽ **Use with caution:** ***Information reporting, subsidies, technical assistance***

Instruments with a strong action-forcing component are the most effective at assuring stakeholders that environmental goals will be met (see table 4-2). For example, all of the single-source, fixed-target instruments—**product bans, technology specifications, design standards, and harm-based standards**—and **integrated permitting** are very effective for assurance since the public can hold sources accountable.

Since design standards are usually somewhat easier to monitor than harm-based standards, depending on how they are implemented in permits, **design standards** are a reliable choice either under a technology-based strategy or to shore up progress under a harm-based strategy when assurance is a major priority.

Although the relative ease of monitoring **technology specifications** and **product bans** makes them attractive instruments, they have seldom been used under the Clean Air Act (CAA), the Clean Water Act (CWA), or the Resource Conservation and Recovery Act (RCRA). Such prescriptive instruments may be most useful in a situation in which the cost of not acting in the short term might be very high.

Tradeable emissions and **integrated permitting**, two of the multisource instruments, also contain strong action-forcing components through provisions for emission caps and the writing of permits. However, we rated tradeable emissions somewhat less effective than integrated permitting and the single-source instruments because of the potential difficulty with monitoring.

At the other end of the spectrum are a set of instruments that might be used with caution if assurance is the major criterion. **Information reporting** can help with monitoring progress but does not require pollution reduction or prevention action by sources. Similarly, **subsidies** and **technical assistance** are almost always voluntary—that is, sources may be asked to reduce pollution but face no sanctions if the program is not successful—which may or may not result in attainment of goals. However, when used as supplements to other instruments, they may increase the overall confidence of the public that goals will be met.

Pollution charges and **challenge regulations** have the potential to move things in the right direction. However, with pollution charges, the action-forcing component is weakened since sources are given an option to pay rather than to reduce their discharges. And our lack of experience with challenge regulations makes them a less reliable instrument at the present time, especially if assurance is the primary concern. More experience in the future with instruments such as tradeable emissions, integrated permitting, challenge

	Fixed Target: Single-source				Fixed Target: Multisource			No Fixed Target				
	Product bans	Technology specifications	Design standards	Harm-based standards	Integrated permitting	Tradeable emissions	Challenge regulations	Pollution charges	Liability	Information reporting	Subsidies	Technical assistance
Assurance of meeting goals	●	0	0	0	●	O	•	•	•	∇	∇	∇
Action forcing	●	a	e	*	●	00		•	•	∇	∇	∇
Monitoring capability	●	●	0		O	∇	∇	∇	∇	•	•	•
Familiarity with use	•	∇	●	●	•	•	V	∇	•	●	●	●

● = Effective O = It depends V = Use with caution •= **Average**

NOTE: These ratings are OTA's judgments, based on theoretical literature and reports of instrument use. The evaluatlon of each instrument on a particular criterion is relative to all other instruments. Thus, by definition most instruments are "average."" Effective" means that the Instrument IS typically a reliable choice for achieving the criterion. "It depends" means that it maybe effective or about average, depending on the particular situation, but it is not likely to be a poor choice. And "use with caution" means that the instrument should be used carefully if the criterion is of particular concern

SOURCE: Office of Technology Assessment, 1995.

regulations, and pollution charges may increase the confidence stakeholders have that they can ensure results.

Instrument-by-Instrument Comparison

● Product bans

Product bans and limitations provide a powerful and clear message to the sources about what is required to meet the goal, and the results are relatively easy to monitor. This approach seems best suited for a situation in which the risks of doing nothing might be very high in the short term or not easily reversed.

For example, if a product poses unacceptable risks to consumers, the agency can prohibit its sale, distribution, and use to eliminate those risks, or the agency can place limitations on the sale, distribution, or use of the product to reduce those risks to acceptable levels. Although they are seldom used by agencies to implement the CWA, CAA, or RCRA, Congress itself has in some instances enacted product bans or limitations, such as the phaseout of chlorofluorocarbons (CFCs).

In markets in which no substitutes are available, the product limitation or ban has the potential to induce technological innovation by stimulating intensive research and development aimed at producing products that are capable of filling the void left by the limited or banned product. The section on *technology innovation and diffusion* discusses this in more detail.

● Technology specifications

Technology specifications have the potential to be very effective at providing assurance, although they are also a very intrusive and prescriptive approach. Once a problem is identified, the targeted entity is told exactly how to act and faces both civil and criminal penalties for noncompliance.

Congress may want to use these standards in instances in which a serious environmental hazard to human health exists and a known technology could provide at least an immediate result. For example, Congress enacted the requirement that new hazardous waste landfills and surface impoundment's install two or more liners and a leachate collection system above and between the liners (255). Although federal environmental statutes seldom direct EPA to enact such specifications, states often specify how sources must carry out their operations in state implementation plans promulgated pursuant to federal environmental standards.

Like design standards, technology-specification standards usually make it simpler for the inspector to ascertain whether a mandated technology has been installed and is working properly than to measure ambient air or water concentrations and relate them to particular sources.

Many observers have little confidence in the ability of legislative bodies or bureaucratic agencies to identify the technology or practice that does in fact meet the intended goal in each individual context. Prescribing a uniform technology for all facilities is not likely to be an efficient approach (7). And, more important, specification standards, standing alone, may discourage dischargers from developing innovative changes in manufacturing processes or recycling technologies to reduce the overall amounts of wasted residuals (3,86,175).

● Design standards

Design standards perform relatively well on assurance when used to meet a technology-based goal. In addition, they are used quite effectively in combination with harm-based standards to provide assurance of some interim progress toward a risk-based goal as well. In either case, the mandatory action and the relative ease of monitoring make design standards a slightly better choice than a stand-alone harm-based standard if assurance is the primary concern.

Design standards, while assuring some progress, can not ensure that risk goals will be fully met. Existing technologies, for example, may not be capable of reducing discharges from a single source enough to achieve the media quality specified by the risk goals. In addition, the cumulative effect of discharges from two or more facilities, each of which complies with the prescribed design standards, could be a concentration of pollutants in the receiving media that still violates the risk goal. Stringent application of the design approach to all new sources might actually slow progress toward risk goals by discouraging companies from replacing older, heavily polluting facilities (2).

In areas that currently meet risk goals, design standards could help ensure that media quality will not deteriorate as rapidly when new sources of the same pollutant are built. In fact, design standards could leave that area "too clean," at least for the present, if the medium can assimilate additional pollutants without violating the risk goal.[2]

The degree of difficulty for monitoring a design standard depends on how the permit is written and whether or not its medium is air, water, or land. If the design standard is translated by the states into an emissions limit, then monitoring might be as complicated and expensive as it is for harm-based standards. However, the compliance officer may also be able simply to check that the model technology is installed and working correctly. For example, if the model technology for volatile organic compounds (VOC) reductions is an incinerator, monitoring the temperature of the device rather than effluent gas concentrations might be sufficient.

Design standards have the advantage when it comes to experience with use. We have used them extensively because they provide a clear course of

[2] Regulated entities frequently criticize an agency for requiring "technology for technology's sake." If the only goal of the regulatory program is to achieve the level of acceptable risk for today, then this criticism is well founded. If the program also seeks to achieve a best-efforts goal, perhaps as a hedge against uncertainties about the future, the criticism is less cogent.

action that is easily enforced, even though they often pose some tradeoffs with criteria like efficiency and technology innovation.

● Harm-based standards

Harm-based standards can be very effective because they provide a clearly designated outcome for each source and some accountability for results. Nonetheless, the analytical complexity and scientific uncertainty of trying to establish a uniform harm-based standard that will actually result in achieving the media quality goals, the difficulties with continuous monitoring, and subsequent enforcement problems make the choice of a "pure" or "solo" harm-based standard a hard one for policymakers who insist on meeting goals.

These difficulties help explain why many harm-based programs end up with a reasonable-efforts floor or abatement strategy added on. Such clauses asking sources to do the best they can until the media quality goals are met provide assurance that some progress will be made.

To satisfy concerns about assurance, harm-based standards need either a technology to monitor emissions or some other widely applicable method for verifying that a source is complying with its limit. If no such technology or technique exists, or if it is too difficult or expensive, an instrument with a lower monitoring burden may be preferred. For example, design standards often include a model technology, whose emission characteristics are known and accepted by regulators, thus avoiding the need for direct emissions monitoring.

Despite all of these concerns, harm-based standards are often preferred over many other instruments because we have enough experience with them to know that they can be effective in assuring source-by-source compliance while nonetheless allowing the sources flexibility to choose the means.

● Integrated permitting

Integrated permitting may be among the more effective instruments at providing assurance, once agencies gain more experience with this instrument. At a minimum, having all of the information regarding a plant's effluent, emissions, and other environmental releases available in a single place, governmental and private citizen enforcers can more easily evaluate the plant's environmental compliance record and decide whether to initiate enforcement efforts.

Using an integrated permit, such as a plant-wide bubble, to give flexibility to a plant or facility to trade off sources may provide adequate assurance to the public—assuming satisfactory monitoring can be installed. For example, 3M anted up improved continuous emissions monitoring for its Minnesota plant in order to gain some flexibility in making changes that affect individual source emissions across the facility.

The integrated approach might also enhance assurance if, during the course of issuing the permit, the agency and sources could identify instances in which requirements promulgated pursuant to one statute conflict with or hinder compliance with requirements promulgated pursuant to another statute. Congress has historically enacted separate statutes for different receiving media and our environmental goals and programs have likewise evolved separately.

Although we are learning, we really do not know how to do multimedia permits well at this point. A source *might* be allowed to reduce its compliance with part of a CWA requirement if it agreed to a more stringent requirement under the CAA, so long as the net environmental risk would be lower than that resulting from full compliance with both requirements. The environmental statutes, however, do not currently allow such arrangements, although EPA has proposed such a possibility for the Great Lakes. In any event, the art and science of risk assessment have not yet progressed to levels that can support such tradeoffs under most circumstances.

○ Tradeable emissions

Tradeable emissions can be an effective tool for providing assurance in many instances. However, since trying to monitor overall reductions made by multiple sources is potentially difficult, we rate this instrument as "it depends."

For sources, this instrument is eventually translated into an emissions limit—usually as the sum of total allowable emissions over some longer time period such as three months or a year, but even over as short a period as a day—plus the amount of credits or allowances that are purchased from other sources. Thus, tradeable emissions share some of the same strengths and weaknesses for assurance as those discussed earlier for harm-based and design standards.

The degree of action forcing is quite similar to harm-based standards. The burdens of monitoring for an effective tradeable emissions program are quite high, but if they are met the program can be quite effective in holding sources accountable. To provide an effective level of assurance of meeting goals, a tradeable emissions program must also have frequent self-reporting and periodic audits by neutral outsiders (71,118,137). Since the ability of a regulator to determine compliance by any single source depends on the integrity of the entire system, monitoring for tradeable emissions may beheld to a higher level of accuracy than for harm-based or design standards.

A very important distinction between this instrument and harm-based standards is that, while the emissions limit for a harm-based standard is location specific, a tradeable emissions program usually provides no assurance that any one source will achieve a specific limit. Thus, the approach works well for certain types of pollutants where environmental quality can be safely based on total loadings over large geographic areas. If, however, emissions at individual facilities, rather than combined emissions from many, are the principle source of concern in a particular area, then moving from a source-by-source approach to a trading program may not satisfy the public's concern over maintaining environmental quality.

A distinct threat to assurance is the possibility of trading units of pollutants that do not represent equivalent risks (42). Under this regime, tradeable emissions could result in a decrease of easily controlled but innocuous substances and a corresponding increase in difficult to control but highly toxic substances.

Tradeable emissions permits are now being used in a variety of settings, including the national $S0_2$ (acid rain) trading program; the Regional Clean Air Incentives Market (RECLAIM) efforts in Los Angeles (see chapter 2); an open market trading system in Tulsa, Oklahoma; and several other small efforts in watersheds. As more experience with this instrument and thus more information on successes as well as difficulties is gained, the public may develop more confidence about the potential for meeting goals.

V Information reporting

Information reporting does not guarantee that any action will be taken by either the source or the public to prevent harm, even though the programs may be relatively easy to implement and may be effective in identifying risks associated with a product or facility. However, reporting require--merits can help an agency assess which activities pose the most serious environmental risks.

Under Section 5 of the Toxic Substances Control Act (TSCA), for example, manufacturers must make EPA aware of the production of new chemical substances or significant new uses of existing chemical substances (256) and must immediately inform EPA of any information that reasonably supports the conclusion that the substance presents a substantial risk of injury to health or the environment (258). EPA may use this information as the basis for regulatory action to protect the public.

In the direct consumer context, information may help consumers identify and reward manufacturers who develop less risky products or technologies. Information reporting may also provide the public the kind of specific information it needs to make a legal case against sources. For example, if a company's monthly discharge monitoring reports filed under the Clean Water Act show that the company is not complying with its permit requirements, an environmental group that becomes aware of those reports can use them in a citizen enforcement action under section 505 of the CWA (246).

Although we have considerable experience with information reporting programs per se, we have little evidence of sustained behavioral changes in protecting the environment. Most of these programs have no mechanism for forcing less pollution from sources and thus cannot assure the public that goals will be met if they are implemented.

V Subsidies

Since they are strictly voluntary, government subsidies, including tax expenditures, are capable of achieving environmental goals only to the extent that the government is willing to pay to achieve those goals and sources are willing to participate. Tax breaks can reduce the pain of compliance with environmental requirements (165) and may be relatively easy to enforce (1 23). However, since participation is strictly voluntary, subsidies might be approached with some caution when assurance is an important consideration.

V Technical assistance

Similarly, although technical assistance can offer companies valuable information and encouragement, it cannot provide stakeholders assurance that environmental goals will be or have been met. Its goal is to persuade sources to adopt best practices or to diffuse innovation in order to move things generally in the right direction. The primary inducement behind such programs is the promise that taking environmentally beneficial action will ultimately save the company money in reduced production or energy costs.

The voluntary nature of such programs means that there is no leverage for forcing actions to achieve goals. Even if companies initially participate, the specific technical assistance can always be rejected, which may happen if the solutions identified are expensive or if the promised paybacks are not fairly immediate.

Challenge regulation

Challenge regulation, one of the less intrusive approaches for achieving environmental goals, gives sources the responsibility for designing and implementing a program to meet the targets established by government. The government would use milestones to measure progress toward the targets and retain the authority to implement a regulatory program should progress be unsatisfactory or the goals not met.

In the short run, since attainment of goals depends solely on industry choices, challenge regulation does not offer much a priori assurance to those who believe goals must be met. On the other hand, monitoring and information systems can be put in place to provide evaluations at annual intervals in order to measure progress toward the goals. If these evaluations are tracked and the targets backed by a mandatory abatement strategy should industry fail to meet them, then challenge might be effective in providing assurance.

The United States has not yet implemented a true challenge regulation, but the voluntary 33/50 program is very similar. Established by EPA in the late 1980s, the program challenged companies emitting 17 targeted toxic chemicals to reduce their emission of toxics by 33 percent by 1992 and 50 percent by 1995 (250). EPA left the impression that if releases were not reduced, it would take additional action under its existing authorities to bring about further reductions (167). Several challenge regulations have been implemented in Europe, including Germany's Green Dot program and several covenants in the Netherlands. However, uncertainty about the effectiveness of such negotiated plans in our very open, highly fragmented system suggests proceeding with some caution.

Pollution charges

To provide assurance to stakeholders of meeting goals, the emissions subject to pollution charges must be easily monitorable and enforceable and the charge must be set high enough to induce the change necessary to reduce emissions. If available pollution reduction technologies will not achieve the goals, a high enough charge may nonetheless provide a continuing incentive to develop alternative technologies. Pollution charges could also make enforcement easier by replacing the bargaining that a company attempts with enforcement officials with the simple approach of "balance due, delinquent charges, plus penalties" (123).

However, not all emissions are easy to monitor. If emissions remain undetected, the source will have no incentive to install pollution reduction technologies, and estimates of progress toward goals will be flawed (7,177).

From the sources' point of view, pollution charges are among the least attractive instruments. Even though charges offer great flexibility in the choice of control method—including the choice of not controlling-they can be quite expensive unless emissions are almost completely eliminated. Sources end up both paying the costs of reducing emissions and paying a charge on any residual emissions, even after the desired levels are met. Thus, if the charge is set high enough to induce change (161 ,220), the owners of polluting sources may decide to resist the fees in available political and legal forums (86,95). Finally, pollution charges may not provide adequate assurance for emergencies and activities that pose risks of low probability but very large consequences (7,123,161,220).

Although Europe has implemented various forms of pollution charges, most are set to raise revenues; only a few have been set high enough to force substantial reductions. Most of the U.S. experience involves technology-based fees such as per-bag fees for residential solid waste. Success with these may make the public amenable to efforts to extend use of charges for other environmental problems.

Liability

A major barrier to liability providing adequate assurance is the very high burden of proof required to establish that the defendant is the source of harm and that the source acted in a manner that was unreasonably dangerous or otherwise socially unacceptable (77,93,1 13,188). If one party is demanding compensation from another party, the courts have been generally unwilling to tolerate uncertainties of the magnitude that are familiar in environmental regulatory regimes (276). The probability of being forced to compensate potential victims is often so low that polluters have little incentive to reduce pollutants to levels that meet the environmental goals.

Ideally, liability can be used both to encourage the prevention of future environmental problems and to fund remediation of existing sites that pose environmental threats when a defendant has been found responsible for harm in a court of law.

■ Pollution Prevention

Pollution prevention is reducing or eliminating pollution at the source of generation through changes in production, operation, and raw materials or resource use.

Pollution prevention is a strategic approach sources can use to meet or exceed environmental goals. Pollution prevention strategies seek the reduction of ***all*** nonproduct outputs, regardless of medium, restricted only by the limits of current process and product technology.

The Pollution Prevention Act of 1990 (PPA) does not mandate prevention but rather states that pollution should be prevented whenever feasible. It does, however, require certain firms to report through the Toxics Release Inventory (TRI) system on their "source reduction activities."[3] Thirty states have enacted pollution prevention statutes,

[3] The Pollution Prevention Act of 1990 (42 U.S.C. 13l0l) defines pollution prevention as". . . any practice which reduces the amount of any hazardous substance, pollutant, or contaminant entering any waste stream or otherwise released into the environment (including fugitive emissions) prior to recycling, treatment, or disposal; and reduces the hazards to public health and environment . . . ."

over half of which include provisions for pollution prevention facility planning. Some have also set statewide numerical pollution reduction goals.

Despite these initiatives, both policymakers and firms fail to adopt pollution prevention strategies as an alternative to pollution control in many instances, even when they may be less expensive in the long run. Explanations for continued reliance on control strategies include a lack of awareness or information about pollution prevention, regulatory disincentives (or lack of incentives), and economic and institutional issues (78,122).

Factors for Comparing Instruments

Policy instruments can provide an advantage for pollution prevention efforts either by giving firms a reason to choose pollution prevention instead of control strategies or by demonstrating the value of prevention strategies so that organizations incorporate them in routine decisionmaking. We compare instruments on their potential for encouraging pollution prevention by assessing the extent to which each instrument:

- gives an advantage to prevention, and
- focuses on organizational learning.

Gives an advantage to prevention

For both regulators and regulated entities, staying with known control technologies is often the least-risky choice even when regulations provide some flexibility of choice because costs, operational conditions, and monitoring capabilities are predictable. Making it easier to use, or even requiring pollution prevention rather than control, is one way that instruments can be effective.

Focuses on organizational learning

Both private and public sector experts typically specialize in air, water, or waste management, with a unique set of language, technologies, and institutional concerns. Moving away from this pattern toward prevention strategies may require considerable learning within organizations. Important issues to be considered include how a firm is organized to make decisions about environmental issues; who makes the key decisions; whether or not top management demonstrates a commitment to prevention, makes resources available, and rewards workers for their efforts; and capacity for flexibility in production processes (146).

In most industrial firms except the smallest, linkages between the production and environmental units have been weak (31). Since pollution prevention seeks to integrate the idea of prevention into production design, organizational leadership or even a change agent at the facility level maybe essential for accomplishing this objective.

Summary of Instrument Performance

● ***Effective: Product bans, technical assistance***
O ***It*** depends: ***Technology specifications, design standards, liability***
∇ Use with caution: —

Most instruments can be used in a way that is compatible with pollution prevention (see table 4-3). While experiences with product bans and technical assistance suggest their effectiveness, neither is extensively used under the CAA, CWA, or RCRA. Product bans eliminate a source of environmental risk and may force the development and use of alternatives. The level of resources devoted to technical assistance is currently too low to reach all firms that could benefit and, in general, is not targeted at larger firms. Implementing combinations of these and other instruments may be essential to improve the use of pollution prevention strategies (141).

Liability may also be effective at prevention because many firms would rather prevent pollution, and thus reduce their liability exposure, than rely on control of large quantities of potentially damaging emissions or wastes.

Although widely criticized as perpetuating preferences for end-of-pipe technologies, both technology specifications and design standards can be used effectively to *promote* pollution prevention approaches. The criticisms are most often summarized as: "standards *require* specific end-of-pipe technology" even though, except in the most restrictive cases, regulated entities are actu-

TABLE 4-3: Pollution Prevention

	Fixed Target							No Fixed Target				
	Single-source				Multisource							
	Product bans	Technology specifications	Design standards	Harm-based standards	Integrated permitting	Tradeable emissions	Challenge regulations	Pollution charges	Liability	Information reporting	Subsidies	Technical assistance
Pollution prevention	*	0	0	.	•	•	•	•	O	•	•	●
Gives prevention an advantage	●	O	O	•	O	•	•	•	O	•	O	O
Focuses on learning	•	∇	∇	∇	•	•	O	•	O	O	•	●

● = Effective O = It depends V = Use with caution •= Average

NOTE: These ratings are OTA's judgments, based on theoretical literature and reports of instrument use The evaluation of each Instrument on a particular criterion is relative to all other instruments. Thus, by definition most instruments are "average." "Effective" means that the instrument is typically a reliable choice for achieving the criterion. "It depends" means that it maybe effective or about average, depending on the particular situation, but it is not likely to be a poor choice, And "use with caution" means that the Instrument should be used carefully if the criterion is of particular concern

SOURCE: Office of Technology Assessment, 1995.

ally allowed to chose "equivalent" methods to meet standards. The de facto requirements come from the practice of setting and applying standards rather than the standard itself.

However, since most design standards were written before pollution prevention became a policy priority, they typically have not been based on pollution prevention concepts or written in ways that accommodate prevention options. Thus, they tend to perpetuate the choice of control technologies. Since pollution prevention often involves process modifications rather than off-the-shelf technologies, continuing to use source-by-source emission standards of any kind restricts the opportunities for using pollution prevention approaches.

Instrument-by-Instrument Comparison

● Product bans

Banning or phasing out a product deals directly with the source of a problem but may require the development of substitutions. Examples include the domestic phaseout of lead in gasoline and paints, the banning of polychlorinated biphenyls under TSCA, and the international treaty on phasing out ozone-depleting substances, commonly referred to as CFCs. A potential problem with **product bans,** as discussed in chapter 3, is that not all substitutions end up being as environmentally friendly as they might first appear or may result in shifts in the location or types of risk. Product limitations, such as labeling and use restrictions, are not necessarily as effective at encouraging pollution prevention options unless compliance costs or public pressure are high.

● Technical assistance

Since these programs are usually voluntary in nature, the decision about whether or not to use **technical assistance is** made by firms. For those that do use the services, technical assistance has been successful in getting firms to use prevention to address specific environmental problems.

The primary argument for using technical assistance has been that firms are much more likely to adopt pollution prevention once they learn about its advantages for specific problems and have access to reliable technical and economic information (204). Whether this kind of assistance alone is sufficient to persuade sources to pursue pollution prevention rather than control strategies on a continuous, long-term basis is not yet clear (55). While the government has learned a great deal about the value of technical assistance, and especially the importance of change agents or key individuals in the agricultural and energy policy systems, application of this approach is relatively new for achieving pollution prevention.

The voluntary, cooperative nature of technical assistance is part of its appeal. However, the success of technical assistance programs lies in demonstrating to regulated entities that altering their behavior and the way they think about solutions to environmental problems can have tangible payoffs. This may require a long period of shared learning and building trust between technical staff in the government or vendor firms and the volunteering firm before the firm is willing to make major changes.

More than 60 programs are operating at the state and local level today, but most are very small. While some of the mature programs may have up to 30 staff people, the average size is four to five people. Thus, even the largest programs "reach only a small fraction of facilities that might benefit" (204).

Design standards

While there is no reason in theory for end-of-pipe technologies to be selected as the model for **design standards**, they generally have been. The model often becomes the de facto standard, despite the fact that design standards may be expressed as emission limits in the agency's final rule. For instance, even though CWA effluent guidelines based on best available technology (BAT) are expressed as effluent limitations, they may be written into a permit as a technology, making prevention a difficult choice (6).

Even when a design standard remains as an effluent limitation, regulated entities face a dilemma. They can choose to minimize the regulatory burden by using the technology they know is the basis for the standard or they can attempt to lower their abatement costs by finding an alternative but pay the cost of proving equivalence to regulators or the facility inspector.

EPA's proposed joint rule for the pulp and paper industry used prevention as the reference control technology for best available technology and made prevention the only way to comply by setting the measurement point for limitations after the process but before the outlet pipe to the wastewater treatment plant. Environmentalists wanted EPA to go further and select total chlorine free (TCF) technology as the reference. EPA instead offered regulated entities a break from monitoring if they used the TCF technology once it was operating and meeting the effluent limitation.

Technology specifications

Technology specifications are straightforward: they either are or are not based on a preventive strategy. There are only a few cases where prevention has been chosen as a technology specification. One example is oxygenated fuel provisions added to the CAA in 1990 to control carbon monoxide. Congress instructed EPA to give preference to oxygenates made from nonfossil sources.

Under RCRA, landfill operators are required to install specific technology, such as special liners and monitoring systems, for hazardous waste facilities. However, this is at a point at which pollution already exists. If the standards raise the costs of landfilling high enough and if those costs are passed back to the waste generator, they create an incentive for pollution prevention.

Liability

Anecdotal evidence suggests that **liability** provisions prompt regulated entities to adopt pollution prevention. The Superfund statute, with its retroactive joint and several liability provisions, has been one of the most effective strategies if judged by this criterion because prevention is perceived as the only sure way of avoiding possible future liabilities. However, Superfund uses a strict liability approach; not all forms of liability create as strong a set of pressures. In addition, impacts from Superfund liability on industries other than the petrochemical industry may be less profound or absent (43).

When firms take into account future liabilities, such as the estimated costs of future litigation and cleanup, in addition to waste management or treatment costs, the comparative viability of prevention projects may increase. While future costs and benefits can be difficult to quantify, newly developed cost-accounting systems include methodologies for quantifying future liabilities.

Harm-based standards

Because a regulated entity is free to choose the technical means it determines is most cost effective for meeting the standard, a **harm-based-standard** is neutral to the choice of prevention or control. However, the fact that they tie the desired outcome to the single-source level of emissions can inhibit initiatives for process-based prevention solutions.

The way harm-based standards are expressed at the facility level can affect prevention. Expressing the standards as a mass-based limit, for example, may increase prevention options, while using concentration limits for water emissions may restrict options to conserve water use. Eliminating part of a waste stream through water conservation might cause a facility to increase pollutant concentrations even though total mass might decrease (209). Mass-based emissions could become technology forcing if an overall cap on emissions is included.

Integrated permitting

The goals of **integrated permitting** may determine whether or not pollution prevention is chosen. These permits can be written in a way that requires or favors pollution prevention strategies, but that is not a necessary feature of integrated permits.

Permitting has traditionally been done separately for sources according to air, water, and waste problems. One goal for integrated permitting is to help resolve these conflicts by allowing multi- or cross-media tradeoffs. Another goal is to change the way an organization approaches choices about environmental solutions in order to increase the adoption of pollution prevention strategies.

For example, New Jersey's integrated permitting program utilizes the information and experience gained from a required facility-wide pollution prevention planning process. Before the permitting process begins, a facility has already examined all its process units (as sources of nonproduct outputs to all media), identified prevention opportunities, and planned an implementation schedule. Despite these types of efforts in several states, it is too early to draw conclusions about the impact of integrated permitting on the adoption of pollution prevention strategies.

Tradeable emissions

Tradeable emissions allow regulated entities to choose whatever method of compliance they determine is most cost effective, including paying for releases, and thus are essentially neutral to the choice of prevention versus control. No empirical evidence to date suggests that these programs can be counted on to stimulate prevention more than control strategies, independent of the cost implications for the firms.

When pollution prevention is the least-cost option for industry, it may be chosen; but other influential factors may include the nature of the environmental problem, the availability of prevention approaches that can produce results in a timely manner, the extent to which the regulated entities use methodologies, such as total cost accounting, and the presence of individuals who strongly support pollution prevention.

Challenge regulations

Because the content and purpose of **challenge regulations** could be so variable, pollution prevention is not necessarily an outcome. The Green Dot program in Germany has had mixed results. Although the evidence indicates that a reduction occurred in some types of packaging materials for large shippers, most other types of packaging were recycled.

Although EPA labeled 33/50 a pollution prevention initiative,[4] the agency used changes in the TRI to measure success. Thus, either a prevention or a control option that reduced releases from a facility would count. EPA did not ask firms to identify what percent of their reductions came from prevention and to explain why pollution prevention was or was not chosen. A number of groups are studying the 33/50 data to determine whether the program's flexibility did, in fact, result in greater pollution prevention.

Pollution charges

Pollution charges, such as waste end fees, emission fees, tipping fees, and permit fees, are rarely set high enough to change behavior, but instead are used to raise revenue for environmental programs. However, even when they are set high enough, they are absolutely neutral toward whether firms adopt a prevention, control, or payment strategy. Pollution charges might encourage pollution prevention if they are made avoidable only through prevention (141).

Information reporting

Requiring **information reporting** may have two potentially beneficial outcomes. First, the information collected may help policymakers make better choices in the future to promote pollution prevention. Second, the way a firm is required to collect and organize information for submission may help it learn more about its own processes and identify opportunities for pollution prevention. Attributing successful outcomes to information reporting, however, may be difficult to justify given the many other influences on sources.

The RCRA Amendments of 1984 required certain hazardous waste generators to include their waste minimization efforts in their RCRA biennial reports. In addition, generators who ship wastes offsite have to certify on RCRA manifests and in permit applications that they have a waste minimization program in place. Despite claims the wastes from the largest generators are being minimized, there is no clear indication that the reporting requirements are the cause (206).

The Toxics Release Inventory, although enacted as a right-to-know measure, has also been characterized as creating incentives for pollution prevention. However, as an information reporting tool for promoting pollution prevention, TRI initially had at least two drawbacks. First, it has counted chemical *releases* from facilities but not chemicals *generated*. Both prevention or control options implemented on the site of a facility can result in reduced levels of reported releases. Second, releases are not necessarily related in any way to production levels.

Facilities subject to TRI are now required to submit annual prevention and recycling reports showing changes over the previous year, using a production ratio. And facilities that claim reductions through pollution prevention must submit qualitative information that help officials understand why and how pollution prevention happens.

State mandates for filing facility planning reports are still another example of trying to use information reporting to promote pollution prevention. As of early 1994, 16 state governments had enacted such laws (226). A major assumption is that the planning process will spur organizational awareness and change as firms discover for themselves the benefits of adopting pollution prevention.

It is too early to evaluate the impact of these programs on pollution prevention efforts in the private sector. Successful outcomes may depend

[4] Under its original title of "Industrial Toxics Project," it was part of the EPA Pollution Prevention Strategy published in February 1991.

highly on a firm's existing culture and staff expertise. If a firm simply hires a consultant to create a report that will comply with the requirements, little learning may occur within the firm. On the other hand, these laws may enable environmental managers inside firms to push for pollution prevention (66).

States have also enacted information reporting programs, such as California's Proposition 65, which allows regulated entities to choose between prevention, such as reformulation to remove a listed chemical, and warning labels for consumer products. These programs have not been fully evaluated for their pollution prevention impact.

Subsidies

Although the federal government does not offer **subsidies** to regulated entities specifically for prevention, some states do in the form of financial assistance, such as grants, loans, or tax deductions or credits, for prevention technology development, demonstration, or application (201).

Since a comparison of subsidies has not been done, their impacts on the investment behavior of regulated entities toward pollution prevention is unknown. For example, it is unclear whether motivated firms find applicable subsidies or the availability of the subsidy motivates the firms.

The effectiveness of subsidies for prevention can be more difficult to verify than for pollution control equipment. The latter is a discrete set of easily recognized technologies, whereas prevention is synonymous with manufacturing processes and products. Other countries have attempted to solve this problem. The Netherlands, for example, allows tax rebates only for a list of cleaner technologies that are preselected on a periodic basis through a special review process.

Environmental Equity and Justice

Environmental equity and justice seeks equality of outcomes, full participation by affected communities in decisionmaking, and freedom from bias in policy implementation.

Traditionally, concern about the distributional effects of environmental protection policies focused primarily on the relative costs and burdens placed on particular industries or on the differential impacts on small versus large or old versus new control sources (see the following section on *costs and burdens)*. Less attention was given to understanding how these policies might redistribute environmental risks and benefits among individuals (99). In fact, the thrust of much of the theoretical literature has been that environmental protection might hurt low-income individuals by eliminating jobs or forcing facilities to relocate (189a).

Over the past decade, however, even these traditional concerns of environmental equity have been recast toward determining the extent to which specific groups of Americans may bear a disproportionate burden of environmental risks. This new focus is now widely referred to as "environmental justice".[5]

The body of empirical research investigating this focus is relatively new. However, initial studies indicate that some minority and low-income communities have experienced adverse impacts from discriminatory siting of facilities and from the implementation of environmental laws (36, 124,194,199,221,225).

These studies generally conclude that minorities and those in low-income communities are more likely to be exposed to higher levels and multiple sources of environmental risks than are whites and higher income neighborhoods. A num-

[5] The literature remains unsettled about which words best identify this new focus. See, for example, D. Ferris, "A Challenge to EPA," *EPA Journal* 18:28, 1992; N. Walker and M. Traynor, "The Environmental Justice Movement: Two Cases in Point," *Environmental Law* 12:3, 1992; R.D. Bullard, "The Threat of Environmental Racism," *National Resources and the Environment,* winter 1993, pp. 23-26, 55-56.

ber of other interpretations of these data have been offered, and attempts to verify the data and, where possible, to clarify the reasons for and the extent of the disparities are continuing (18,20).

Advocates of environmental justice seek to institute the following set of principles for decisionmaking on environmental issues: "right to protection, prevention of harm, shifting the burden of proof, obviating proof of intent to discriminate, and targeting resources to redress inequities. . ." (23). These principles restate environmental priorities to address the concerns of minorities and other vulnerable populations that environmental issues are issues of equity, social justice, and public health, not conflicts requiring tradeoffs between health and economic well-being (24,25).

Environmental equity and justice is now one of the standards against which environmental protection policies are measured. For example, federal agencies are now required to address the "disproportionately high and adverse human health or environmental effects of its programs, policies, and activities on minority populations and low-income populations" (268). The EPA, which has characterized environmental justice as concerned with identifying and addressing disproportionately high and adverse human health or environmental effects in minority populations and in low-income populations, incorporates it as one of its six "guiding principles" for strategic planning (213). More recently, the Clinton Administration's "10 Principles for Reinventing Environmental Protection" incorporated ideas of environmental equity and justice as well (32).

Factors for Comparing Instruments

The concept of environmental equity and justice encompasses multiple concerns, ranging from funding more research to identify the disparate impacts of environmental policies to developing more effective strategies for achieving the goals. At the heart of the environmental justice concept is the theme that environmental policies have discriminated against racial minorities and low-income communities in both direct and indirect ways (63). A major concern is that, through their neighborhoods, jobs, and diet, these groups are exposed to more pollution than are other members of the public.

Many of the strategies for pursuing environmental equity and justice, while important, involve initiatives that fall outside the scope of this assessment. For example, efforts to reshape the siting procedures for hazardous waste facilities in the states can be important for achieving equity and justice goals. However, procedural improvements for decisionmaking are not instrument specific in effect.

In this section, OTA has restricted its comparison of the policy instruments to three major components of environmental equity and justice:

- distributional outcomes of policies;
- effective participation in policymaking; and
- remediation of existing problems.

Distributional outcomes of policies

The redistribution of risks and benefits through implementation of environmental laws occurs at varying geographic scales. For example, some areas of the country, notably urban areas such as Los Angeles, have much higher concentrations of air pollutants such as ozone than do rural areas. Within a local community there may be large differences among neighborhoods in the relative exposure to hazardous or toxic substances. These types of inequities, especially in the absence of compensating benefits, are a primary concern for achieving environmental equity and justice.[6]

This report looks at two specific types of distributional outcomes that are central for trying to protect all members of the public. First, environ-

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[6] Economists have used the assumption that winners will pay losers to "wash out" the distributional inequities that ultimately develop in any real-world implementation of policies. This has generally not happened, although the idea of direct compensation for siting has been adopted by some states; see V. Been, "Compensated Siting Proposals: Is It Time To Pay Attention?" *Fordham Urban Law Journal* 21(3):787-826, 1994.

mental equity and justice seek to address the issue of protection for the most vulnerable populations, especially since evidence exists that environmental regulatory agencies have failed to protect these populations adequately in the past (189,208).

For example, in establishing water quality standards, proponents point out that fish consumption data are usually averaged across populations and may miss special sensitivity within smaller subgroups such as Native Americans (222). It is this more sensitive group. according to advocates, on which the regulations should be established since they not only eat more fish but also more of each fish, often including the head and tail, which are parts with higher bioaccumulation (92).

Second, proponents of environmental equity and justice are concerned that, once that level of protection is set, the actual levels of exposure to pollutants should not differ across individuals or groups. For example, proponents argue that, if national standards are set for air pollution emissions, no individual should be more exposed than another individual. Thus, differential exposure across areas of the country or within local communities—so-called "hot spots''—would not be acceptable. This proposition is based on the claim for a "civil right to equal protection" from environmental harm (34,65,191).

Effective participation in policymaking

Another major component of environmental equity and justice is to establish informed and meaningful participation in all decisionmaking arenas where specific environmental policies are developed (52). By forcing policymakers to consult with communities and local grass-roots leaders, proponents expect to achieve higher visibility for their ideas and to change the regulatory culture for environmental policymaking at the federal level (35,61,191).

A major difficulty is often the discrepancy between the capacity of industry and government and that of minority and low-income communities to participate as equals. Language barriers, convenience of the forums, and lack of technical preparation are examples of problems that may have to be overcome for individuals to get involved in neighborhood and community problem solving (26).

Remediation of existing problems

Some minority and poor communities also have experienced discrimination when decisions have been made about siting hazardous facilities and about choosing priority sites for cleanup (98). Yet efforts to establish remediation through equal protection suits have been generally unsuccessful (65). While remediation will continue to be a concern in the short run, because communities cannot simply move away from their problems, the ideal is to eliminate the need for remediation efforts in the future by emphasizing pollution prevention strategies.

Summary of Instrument Performance

- ● ***Effective: Information reporting, subsidies, technical assistance***
- O It depends: —
- V Use with caution: ***Tradeable emissions, challenge regulation, pollution charges***

The concerns of environmental equity and justice are not easily addressed by the choice of policy instruments. In fact, many of the proposed strategies for achieving equity and justice—including redesigning administrative processes to secure more meaningful participation, establishing an active enforcement and compliance program, requiring more financial and analytical support of environmental justice issues, and strengthening environmental goals—for the most part require actions that are far beyond the scope of this assessment.

Instrument choice is not a particularly effective way to achieve those goals, although few of the instruments actually impede the goals. In fact, most of these instruments can be used in a manner that is either consistent or inconsistent with seeking one or more of the factors that are part of environmental equity and justice.

The most effective instruments for achieving environmental equity and justice are those that can provide either financial or technical assistance

TABLE 4-4: Environmental Equity and Justice

	Fixed Target							No Fixed Target				
	Single-source				Multisource							
	Product bans	Technology specifications	Design standards	Harm-based standards	Integrated permitting	Tradeable emissions	Challenge regulations	Pollution charges	Liability	Information reporting	Subsidies	Technical assistance
Environmental equity and justice	.	.	.	.	.	∇	∇	∇	.	●	●	●
Distributional outcomes	.	.	.	●	.	∇	∇	∇	.	.	.	.
Effective participation	.	.	.	.	.	∇	∇	∇	.	●	●	●
Remediation	.	.	.	.	.	.	.	.	●	.	●	●

● = Effective O = It depends V= Use with caution . = Average

NOTE These ratings are OTA's judgments, based on theoretical literature and reports of Instrument use. The evaluation of each Instrument on a particular criterion is relative to all other Instruments Thus, by definition most instruments are "average." "Effective" means that the Instrument is typically a reliable choice for achieving the criterion "It depends" means that it maybe effective or about average, depending on the particular situation, but it is not likely to be a poor choice, And "use with caution" means that the Instrument should be used carefully if the criterion is of particular concern

SOURCE Off Ice of Technology Assessment, 1995

to community groups and other organizations to enhance and improve their capacity to become involved in decisionmaking and to affect progress toward local environmental quality (see table 4-4). Although boosting the participation of such groups may help with *assurance of meeting goals,* the purpose goes beyond that criterion to seek the views and ideas of those individuals likely to be affected by choices about priorities and programs.

Several instruments have the potential to provide funding to help local communities. For example, although **liability** has been quite controversial, it nonetheless could provide a vehicle for obtaining remediation funds for cleaning up environmental hazards. **Subsidies** can also be used in similar ways. **Technical assistance** can increase the capacity of communities to understand the environmental risks in their communities and prepare them for participation in technical proceedings. And **information reporting** by facilities and government agencies alike can be critical for communities trying to evaluate the environmental risks they face.

In the case of distributional outcomes, instrument choice may bean important issue. For example, requiring all sources to adopt the same pollution abatement capacity regardless of the ambient environmental quality in an area, as a **design standard** does, cannot address the fact that some areas may have multiple facilities and thus face relatively higher exposure levels. In contrast, **harm-based standards,** which are typically based on the media quality in an area, could be tightened for sources that are discharging pollutants into areas with relatively poorer air or water quality.

Three instruments---tradeable emissions, challenge regulation, and pollution charges—may create serious problems if equity is a major concern. The first two give firms or industries the choice regarding which facilities will make improvements in performance and in which order these improvements will be made. Thus individuals in one area of a region could be comparatively worse off even though others are much better off—even though the overall environmental performance for the industries or firms involved is improved. In the case of pollution charges, firms have the choice of paying the charge per unit of pollution emitted or discharged rather than controlling or reducing the pollution.

None of the instruments per se are very effective at ensuring that groups are experiencing the same exposure levels of pollutants. The real gains for improving distributional impacts are likely to come through improving the quality and level of participation in environmental policymaking and increasing efforts to secure remediation of existing problems. However, these changes are more likely to be successfully pursued through changing social and political values rather than through instrument choice.

Instrument-by-Instrument Comparison

● Information reporting

Information reporting can aid the goals of environmental justice in several important ways. Information can be used by researchers to identify ongoing environmental problems and to improve our understanding of effects of exposure on individuals and communities, by citizens to improve grass-roots participation in decisionmaking, and by government officials to identify and respond to inequities in the implementation of environmental policies.

For the public to participate fully in decisionmaking, communities need adequate notice, accurate information, and an understanding of the community and individual risks involved. One of the factors that led to the environmental justice movement was the increase in public knowledge about the nature of transfer and storage facilities for toxic and hazardous waste provided by changes in right-to-know laws and “cradle-to-grave” manifests (35).

Publicly available information from facilities can also be used by technical experts to help educate and empower local groups (35). Changes in right-to-know laws have empowered minorities and local communities. The Environmental Justice Committee of the California Comparative Risk Project recently recommended that the state expand community right-to-know opportunities because of their demonstrated effectiveness in several disputes (26).

● Subsidies

The Environmental Justice Act proposed a number of **subsidies** to promote its goals (269). It contained provisions for grants, for example, to support inspections of facilities and research on environmental issues. It also directed EPA to establish user fees on toxic chemical facilities to be used in funding the grants.

Grants are particularly useful instruments for funding such projects as remediation work at existing facilities or abandoned property, technical education and training of members of minority or low-income communities to prepare them for careers in environmental science and engineering, and research on health impacts in communities with a history of high exposure to pollutants. EPA, for example, is providing subsidies to several health clinics, including one in Torrance, California, to help communities assess the health impacts of high exposure levels to toxics (46).

Financial compensation to communities for accepting hazardous facilities has been a widespread practice in states. The Massachusetts Hazardous Waste Facility Siting Act, for example, has been sited as a model for other states and Wisconsin has experienced moderate success using compensated siting. However, many grass-roots organizations and communities have opposed the concept of compensating communities for the inequitable burden they bear by accepting a hazardous waste facility (19).

● Technical assistance

Technical assistance can be a powerful tool for improving the capacity of communities to evaluate for themselves the status of environmental problems in their communities and to work more effectively with government and industry in developing solutions (191). For example, programs can be developed to provide information about environmental problems and issues in the community's primary language, to train local workers in the kinds of practical skills needed to participate in decisionmaking or in monitoring environmental problems.

Technical assistance programs are currently available under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) to help communities hire technical advisors. However, administrative requirements for obtaining the grants have impeded efforts to take full advantage of them (52). Such technical assistance is especially important for helping communities understand and evaluate the cleanup status of remediation projects.

EPA has awarded a number of grants to local organizations representing low-income and minority communities to implement programs to advance the goals of environmental justice. Six Massachusetts community groups, for example, received small grants for activities to reduce lead contamination, complete research on air quality, and survey public housing communities to identify environmental concerns of residents (44).

▽ Tradeable emissions

Tradeable emissions, one of several multisource instruments that treat emissions from a group of sources or facilities as a single source, might be used with caution if distributional issues are a concern. In a tradeable emissions program it is possible that, even though the emissions cap is stringent enough to protect the overall population, the patterns of the trading may lead to very different levels of exposure for individuals. For example, one possible outcome is the further aggravation of pollution hot spots in minority or low-income communities and neighborhoods (4,155).

This is not necessarily the case, however. As discussed in the case study of the RECLAIM program in Southern California in chapter 2, little difference is expected for the Los Angeles area in the exposure outcomes for minorities between RECLAIM and a more traditional regulatory alternative. Moreover, since the emissions cap is increasingly stringent over the life of the program, everyone should be better off.

▽ Challenge regulations

Challenge regulations focusing on industry sectors or large individual firms represent a potential threat to the idea of emphasizing the distributional effects of environmental policies. A major strength of challenge regulations is that they set standards at a larger geographic scale than the facility level in order to improve opportunities for efficiency and innovation in meeting goals. They also emphasize less formal administrative proceedings in favor of more consensus-based decisionmaking.

But when standards or targets to be met are established by industrial sector rather than for a facility or source, the distribution of environmental impacts is uncertain. Particularly when standards cover a relatively large geographic scale, the exposure patterns for the area will depend on the choices of specific companies or facilities. However, since overall emissions would be reduced, everyone should be less exposed than when the program was initiated.

The implications of challenge regulations for participation are uncertain. If decisionmaking moves more toward negotiation between regulators and industry, the capacity of minorities and low-income individuals to participate may be even more constrained.

▽ Pollution charges

Pollution charges are unresponsive to concerns about the unequal distributional impacts of environmental policies. Their strength lies in the simplicity of administration and uniform application to all discharging sources. The disadvantages in terms of equity and justice are twofold. First, such uniformity in the implementation of charges prevents taking actions to improve hot spots by ratcheting down the allowable discharges from specific facilities. And second, a facility has the right under such a program to pay the fee and continue discharging regardless of the impacts on environmental quality.

One possible advantage of pollution charges might be the use of fees to fund remediation efforts in particular communities. The charges might be placed in a fund for use in the future or used to clean up existing sites.

Product bans

Actions to alter product status may enhance the goals of equity and justice by benefiting all of us. However, they may also increase protection for minorities and the poor, who are often more exposed than others. For example, pesticides are more likely to be handled by farm workers, increasing their exposure through multiple pathways (144). Since toxic and hazardous products are more likely to be handled by minority and poor employees (60), efforts to reduce risks through **product bans** or limitations might provide more direct benefits to these workers.

Technology specifications

The uniformity of **technology specifications** goes to the spirit of ensuring that any facility that is built uses equally performing technology. However, since these standards are uniform for sources, they will not be effective at addressing pollution problems in areas with multiple sources or with unique conditions.

Formulating these standards requires considerable expertise and knowledge of the equipment and industrial setting. The process for rulemaking can also be lengthy and focus on highly technical issues. These circumstances may work against some grass-roots organizations participating effectively in formulating policies.

Design standards

Design standards are often established based on a determination of what it is possible for an industry to do, rather than according to public health concerns. By requiring that every facility do the same thing, design standards cannot accommodate all of the concerns of communities that already have a large number of facilities in the area.

While new sources usually have to adopt state-of-the-art technologies, older facilities may not have to do so, at least until their permits are renewed. Especially in communities which have a large number of older facilities, this instrument will be generally unresponsive to concerns about distributional impacts. Yet, as discussed in the section on *assurance of meeting goals*, design standards may be a safer bet for getting actual reductions in pollution levels than more complex approaches, simply because they are relatively easy to administer (95).

Harm-based standards

Since **harm-based standards** are typically expressed as a mean or maximum permissible discharge from a particular source, they can be adjusted to respond to differences in exposure levels at the community level.

For problem areas such as those with unique meteorological conditions, harm-based standards could be particularly useful for bringing the ambient quality in line with surrounding areas. However, efforts to base harm-based standards on the most vulnerable populations rather than on average populations may run into difficulties because of the statutory language describing the basis for the standard.

Harm-based standards are not very effective in promoting participation by a wide range of individuals. The technical quality of most proceedings makes it difficult for most members of the public to take advantage of the public participation opportunities offered under administrative law, such as public notice of rulemaking, notice and comment periods, and representatives allowed to participate in siting, regulatory negotiation, etc.

Integrated permitting

Integrated permitting, in contrast to the other multisource instruments, is used to increase flexibility in controlling emissions across sources in a single facility. Thus, it is unlikely that substituting an integrated permit for a single media or single-source permit would create a large difference in the distributional impacts around a facility. Overall, permits implemented as facility bubbles, allowing facility-wide trading of source emissions, should be neutral for equity and justice concerns.

There is no evidence to date that integrated permitting has explicitly incorporated concerns about greater participation by minorities or other member of the local public. In fact, these permitting initiatives have been developed by state and industry officials, rather than by the environmental advocacy groups (149). However, it seems likely that a more systematic, comprehensive inventory of a facility and the subsequent filing of a permit with that information in one place could improve the quality of information available to the public.

Liability

Liability could provide a mechanism for seeking funds to be used in remediation work, thus aiding environmental justice goals. The CAA and RCRA do not provide a mechanism for those alleging injury from pollution to seek compensation; the CWA, as amended by the Oil Pollution Act (OPA) following the Exxon Valdez incident does allow compensatory damages. CERCLA, or Superfund, which imposes strict and joint and several liability on anyone whose disposal of hazardous substances causes a property owner to incur remediation or cleanup costs, has been widely criticized (248). Nonetheless, it has given members of the public a mechanism for getting support for cleanup efforts (52).

COSTS AND BURDENS

Although meeting environmental goals remains a priority, the public is also concerned that these goals be achieved at the lowest possible cost and with the fairest allocation of burden among companies and between government and industry. Congress has seldom set goals without including a concession to the costs and burdens imposed. In some instances, however, the desire to provide sufficient protection of human health or the environment has resulted in the use of strict source controls and additional requirements, such as continuous monitoring, which has added significant **costs and burdens**.

One of the most pervasive concerns about environmental protection programs in the United States has been that they are costly to implement, thus reducing productivity and placing firms at a competitive disadvantage. Certainly, identifying and implementing policies that are effective at improving both **cost-effectiveness and fairness** has not been an easy task.

Concerns about the administrative **demands on government** has also intensified. Especially pertinent to this study have been claims that some alternatives for protecting human health and the environment offer the advantage of placing a significantly lighter burden on government, either by shifting the burdens to ward other groups—industry or consumers—or by loosening the level of control altogether.

The following two sections—cost-effectiveness and fairness and demand on government—present OTA's assessments of which instruments might be most effective in lessening burdens and lowering costs.

■ Cost-Effectiveness and Fairness to Sources[7]

Cost-effectiveness and fairness to sources considers protection of human health and the environment at the lowest possible cost and with the minimum burdens on industry.

Concern about the impact of environmental regulations on U.S. productivity as well as the impact of compliance costs on sources has been a recurring theme in the environmental policy community since the 1970s. However, current ef-

[7] Parts of this section are based on C.S. Russell and P.T. Powell, "Efficiency and Fairness of Candidate Approaches to Environmental Pollution Management," umpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, May 1994.

forts to improve the performance of the U.S. economy in comparison to other countries have heightened the scrutiny given to the relative effect of environmental policy choices on cost-effectiveness and fairness (73,88,197).

One of the most consistent criticisms of environmental regulations in the United States has been that they force very inefficient activities on sources while also placing heavy administrative demands on regulatory agencies (88). Such criticisms often assert that using different policy instruments, particularly economic incentives, would result in accomplishing the goals at lower costs for both sources and the government (4,22, 145,200).

Evaluating which instruments use resources in the most efficient and fair way, given an environmental goal, has sparked considerable academic and political debate over the past 2 1/2 decades (37). However, a major barrier to comparing the efficiency of policy instruments has been the paucity and poor quality of information on the social benefits of pollution abatement, in comparison to the availability of reasonable, if imperfect, estimates of compliance costs (9,192). Moreover, there is little systematic empirical evidence that economic incentives are effective in changing the behavior of sources in the desired direction (81). In fact, experiences with real-world implementation of these instruments suggest that the conclusions about relative performance on efficiency that are derived from theoretical studies should be interpreted cautiously (197). Yet, even when political compromises and negotiation among stakeholders in a particular context make pure efficiency unreasonable to seek, it may be possible to identify second-best strategies that allow at least some potential for cost savings.

Factors for Comparing Instruments

Instruments that are cost effective—for sources and for society as a whole—have a relatively low administrative burden for industry and for government and are viewed by sources as evenhanded. Despite continuing efforts to implement strategies which are both cost effective and fair across the board, most situations seem to require tradeoffs among some the following four components:

- cost-effectiveness for society;
- cost-effectiveness for individual sources;
- fairness to sources; and
- administrative burden for sources.

Cost-effectiveness for society

This study does not attempt to assess the benefits or value of a legislatively determined goal, but rather assumes that Congress has chosen a statutory goal that captures the desirable level of social benefits (97,142,170). Thus cost-effectiveness for society considers the total industry and government expenditures per unit of pollution abatement required to meet the environmental goal. The maximum net benefits to society for accomplishing a particular goal would be achieved by use of the instrument with the lowest total of expenditures by industry, government costs, and transfers of money to and from government—for example, through taxes or subsidies.

Cost-effectiveness for individual sources

Another measure of cost-effectiveness is at the firm level—that is, does the instrument allow a firm to minimize its costs for compliance. In most studies, the goal is assumed to be an unchanging one and the regulator and the firm are interested in finding the least-cost solution in that particular context (21). However, the potential of long-run cost-effectiveness, where an instrument allows the firm the flexibility to continue seeking least-cost adjustments over a period of time, is also important. The following sections on *adaptability* to change and *technology innovation and diffusion* discuss the importance of allowing sources and regulators more flexibility to respond to dynamic conditions.

Some instruments can be cost effective for society but not for a firm, and vice versa. This is particularly true for those instruments that transfer money from firms to government (taxes) or from government to firms (subsidies).

Administrative burden for sources

Another concern for regulated industries is the extent to which various instruments add burdens, especially those that do not seem necessary to accomplish the environmental goal. The most typical responsibilities firms have are problem solving (e.g., information, technologies, prices, expertise, etc.) and monitoring (auditing and reporting emissions of pollutants). Unless they expect changes to a regulatory program to be particularly efficient compared to other options, sources may resist taking on such additional costs as new analytical studies, extensive reporting requirements, fees for service, or certification costs. This may be the case particularly when sources view the requirements as unrelated to achieving environmental goals or as adding legal costs or delaying production schedules. On the other hand, they may be supportive of an alternative that, although adding initial costs, gives the firm greater responsibility for and control over the development and implementation of solutions.

Fairness to sources

Fairness is usually in the eye of the beholder. Accordingly, this report assesses the perspective of sources on how the instruments might affect either their choices or their competitive position vis-à-vis other similar firms. (For a consideration of fairness from the perspective of how instrument choice affects individuals and communities, see the preceding section on *environmental equity and justice*.) When choosing among environmental policy instruments, an agency typically confronts an inherent tension between treating all sources as if they were the same (uniformity of treatment) and trying to assure that all sources experience the same outcomes (uniformity of outcomes) because few policies, if any, can achieve both.

Within an industrial sector and even within some firms, there are always important differences in size, age of facilities, location, financial arrangements, profitability, etc. These differences ultimately create tensions for government in making specific policy choices. For example, under what circumstances might it be best to treat small and large firms alike, even though the small firms might be placed at a competitive disadvantage? Are there other circumstances in which it might be better to choose a different policy that regulates small and large firms very differently in order to promote a more equal outcome among all the sources? Uniform national standards could be judged "fair" in the sense that everyone is treated the same. But differences in firm characteristics, such as type of industry, type and volume of production, location and age of facilities, and technology performance, may have more bearing on how a firm is affected by a policy and thus how it assesses fairness.

Another dimension of fairness to sources is the extent to which a policy instrument allows a firm some autonomy in choosing environmental strategies for itself. Although firms argue that this autonomy gives them the requisite flexibility to achieve least-cost solutions, the principle of private sector control over internal decisions regarding process- and product-related changes is also an ideological issue in American culture.

Government policies can sometimes be crafted to satisfy all of the sources, but not very often. Most approaches involve tradeoffs between degrees of equality of treatment and equality of outcome (106).

Summary of Instrument Performance

- ● **Effective: *Tradeable emissions***
- ○ **It depends: *Integrated permitting, challenge regulations, information reporting, technical assistance***
- ▽ **Use with caution: *Product bans, technology specifications***

The most effective instruments for promoting cost-effective and fair use of resources are those that expand the range of options for sources at the facility level or higher to respond to environmental regulations. This will be particularly true where high variability in marginal abatement costs among stationary sources provides the po-

TABLE 4-5: Cost Effectiveness and Fairness

	Fixed Target							No Fixed Target				
	Single-source				Multisource							
	Product bans	Technology specifications	Design standards	Harm-based standards	Integrated permitting	Tradeable emissions	Challenge regulations	Pollution charges	Liability	Information reporting	Subsidies	Technical assistance
Cost-effectiveness and fairness	∇	∇	•	•	O	●	O	•	•	O	•	O
Cost-effectiveness for society	∇	∇	•	•	•	●	O	●	•	O	∇	•
Cost-effectiveness for sources	∇	∇	•	•	O	●	O	•	•	O	●	●
Fairness to sources	∇	∇	•	•	•	●	●	∇	∇	•	•	•
Administrative burden to sources	•	•	•	•	∇	∇	∇	•	∇	•	•	•

● = Effective O = It depends V = Use with caution . = Average

NOTE: These ratings are OTA's judgments, based on theoretical literature and reports of instrument use. The evaluation of each instrument on a particular criterion is relative to all other instruments. Thus, by definition most instruments are "average." "Effective" means that the instrument is typically a reliable choice for achieving the criterion. "It depends" means that it maybe effective or about average, depending on the particular situation, but it is not likely to be a poor choice. And "use with caution" means that the instrument should be used carefully if the criterion is of particular concern

SOURCE: Office of Technology Assessment, 1995.

tential to achieve significant cost savings by relaxing uniform control requirements for all sources. Conversely, those instruments for which we recommend using caution—product bans and technology specifications-require uniform control of all sources, regardless of the cost.

Tradeable emissions offer the best opportunities for efficient and fair use of resources in comparison with other approaches (see table 4-5). Tradeable emissions give firms holding facility permits the options of trading, pollution abatement, or a mix of the two, depending on which strategy meets their needs, as long as the overall choices of multiple firms are within the program rules and will meet the ambient environmental standards established for an airshed or water quality limited stream (16).

Integrated permitting and challenge regulations can open opportunities for such interfirm strategies as trading, information sharing, and technology innovation or diffusion within an industrial sector. For both instruments the initial costs and hassle of establishing a program and maintaining adequate monitoring might be substantially increased for both industry and government, although over the long run this may become less burdensome.

Information reporting and technical assistance also have the potential to be quite cost effective and fair, depending on their design and associated requirements. Although information reporting usually requires additional work by firms, they usually prefer this approach since it leaves choices about reduction strategies to the firm. Similarly, technical assistance is usually free to firms and so is obviously cost effective for them. However, neither instrument requires that firms produce results toward the environmental goal, so we have rated them as "it depends."

Pollution charges, while cost-effective for society, ultimately fall short on the fairness issues. Charges allow firms the flexibility to identify the point at which it is more cost effective for them to pay the charge than to reduce pollution. Also, a charge system, once in place, is relatively easy for government to administer in comparison to many of the other instruments. However, firms are not likely to consider paying both the cost of pollution reduction investments to meet the goal and charges on the remaining pollution as fair.

The instruments that we have rated "use with caution"—**technology specifications** and **product bans**—are usually implemented for other reasons, such as assurance of meeting goals. Because they require all firms, facilities, or products to meet the goal in exactly the same way and within the same timetables, they restrict opportunities for identifying facility- or industry-specific, least-cost solutions in the short run. In addition, locking the technology standard or product restriction into a firm's production routines is likely to create a disincentive to seek a more efficient solution. The uniform treatment of sources could be considered fair only in the restricted sense that each source must meet the same requirement. The widely disparate impacts on the expenditures required by firms within the same industry or across industries may be perceived as unfair by the majority affected.

The remaining instruments fall somewhere in the middle. That is, they could be efficient or fair depending on the particular context in which they are used, but the inherent characteristics of the instruments themselves do not seem as promising for success on this criterion as do tradeable emissions, integrated permitting, challenge regulations, and technical assistance. Other tools, like subsidies, may be very cost effective for firms, for example, because they are free or relatively low in cost to the firm. However, other factors such as the costs to government or the perception of lack of uniform availability because of resource constraints restrict their overall performance on this criterion.

Instrument-by-Instrument Comparison

● Tradeable emissions

Tradeable emissions have the potential to perform very cost effectively and fairly. They offer an opportunity to lower per-unit expenditures for pollution abatement. Firms are given flexibility to seek least-cost solutions and a clear set of rules, allowing the government to get out of the way once the targets have been established. In addition, most firms are already familiar with permits and thus may be comfortable with the idea of a permit-based system.

However, early efforts to establish RECLAIM suggest that, at least in the short run, the analytical and administrative burdens on both industry and government will be considerable (15). These additional transaction costs lessen the cost-effectiveness of abatement under a tradeable emissions regime, although they may lessen over time as agencies gain more experience.

The initial allocations of permits can be every bit as time consuming and analytically difficult as harm-based and design standards. In addition, in the end they may not be evaluated as fair by all since the process and outcomes are likely to reflect political compromise rather than optimization of efficiency concerns. Any efforts to change the permit allowances or schedules once they are in place may be viewed as unfair because it would be changing the rules. However, once the initial allocations are set, no firm can be made to trade or to be worse off with a tradeable emissions program than it would be with a straight harm-based standard written into a permit.

○ Integrated permitting

One of the key arguments for using **integrated permitting** is that it is more cost effective for both sources and the government agency than permitting a facility separately for air, water, and solid waste. Cost savings could be realized if the firm is able to find more cost-effective ways to meet existing requirements or if the firm and agency incur fewer administrative costs because of the coordinated permitting process.

However, at least initially, the learning curve for this instrument may require more investment of time and resources for writing new permits for which there is no model or example (149). Firms may be able to identify ways to prevent pollution at a lower cost than reducing pollutants in some facilities. However, early experiences in New Jersey and in Minnesota suggest that states and the sources have underestimated the personnel, research, documentation, and time required to complete the permits.

Nonetheless, if a facility is large enough and has multiple sources of the same pollutant, such as many of the refineries in the mid-Atlantic and Gulf Coast area, a facility-wide harm-based standard (or bubble) may be a very cost-effective approach for pollution control and would be judged more fair by sources than source-specific emission limits. The 3M plant in Minnesota, for example, has used the integrated permitting tool to establish a facility bubble in which they have a VOC facility cap rather than specific source limits. To satisfy concerns about violations, 3M developed a continuous emissions monitoring system (149).

Challenge regulations

Challenge regulations redirect the government's effort from facility level standards to the next level up (e.g., industry or regional level standards), allowing firms to determine for themselves how they intend to comply, thus providing an opportunity for an increase in cost-effectiveness for firms and a decrease in overall abatement costs in comparison to the costs of using uniform source controls. The opportunities for cost savings at the national and firm level also improve because sources participating in determining the means for meeting the targets can identify potential market and technology constraints. In addition, because of their ability to participate, sources may see this approach as generally fair for meeting goals (152).

The Dutch have used a type of challenge regulation that combines statutorily-based, long-range environmental targets for industry sectors and a system of permits specifying the level of control should the targets not be met. Once the government sets the targets, it works with specific industries or even individual large firms to establish agreements outlining how the targets will be met.

Although data are not yet available to assess whether or not the firms involved believe they have been able to achieve more cost-effective solutions than they would have under another approach, some potential benefits from participation in such an approach include overall savings at the industry level through, for example, emissions trading, cooperative activities to spur technology innovation or diffusion, and reduced financial liability (39,134).

Germany's Green Dot program, which encourages reduction of packaging waste, is also an example of challenge regulation. The mixed results achieved to date suggest using caution if adopting this approach in order to achieve the best possible results.

The United States has had no experience with challenge regulation, although the 33/50 program is somewhat similar. The major component 33/50 lacks is the backstop of mandatory requirements should industry fail to meet the targets established.

The primary concern over fairness to sources focuses on companies that may refuse to participate in pollution abatement efforts (free riders), forcing other firms to overcomply or risk failure (53). Thus industries may want the agency to enforce challenge regulations once choices have been made. Concerns may also exist over the potential for corruption in reporting and compliance activities given the difficulty of monitoring. However, the potential for industry acceptance of environmental targets established through challenge regulation is high given industry's participation in determining the feasible means for meeting the targets (39).

○ Information reporting

Information reporting by firms regarding the types and quantities of pollutants emitted provides the agency and the public information about some of the environmental impacts of facilities. Political choices about priorities for environmental protection, either locally or nationally, can thus be made more carefully (11,12). Accessible information about facilities in an area could be used by the public in making such choices as where to live, when to seek actions requiring a facility to improve its performance, etc.

Possibly of greater importance, information reporting may induce firms to identify the magnitude of problems and develop solutions voluntarily (12). Each firm can weigh the costs of control against the benefits from improved public perception. While this allows each firm to choose the most cost-effective means to lower emissions, this may not be a particularly fair way to lower emissions.

Costs to government come in the form of administrative responsibility for database development, management, and, if desired, distribution to the public. However, information reporting programs such as the TRI may be less burdensome for government to administer than an alternative regulatory scheme.

○ Technical assistance

Technical assistance is essentially a cost-reducing program for sources because the government provides the infrastructure costs for maintaining state-of-the-art expertise and outreach capacity. Firms that choose to participate are not obligated to use the assistance they are offered. If they do not benefit from the assistance, the high costs to government would obviously outweigh the cost savings to industry.

Nonetheless, most programs are directed at small firms that may operate with limited information concerning the nature and impact of their emissions or what the best practices might be for minimizing emissions. Programs that disseminate information or turnkey programs utilizing new abatement capability, for example, could provide cost savings. (See the following section on *technology innovation and diffusion* for a discussion of diffusion of new technologies.) Under these circumstances, technical assistance programs have the potential to help firms make more cost-effective decisions about meeting environmental regulations. The ultimate test for the cost-effectiveness of technical assistance programs is the extent to which they are successful in motivating the kind of behavioral changes regulators want.

▽ Product bans

Product bans and limitations are not used because of concern over efficiency; in fact, almost no literature exists that examines their performance on efficient and fair use of resources. In addition, firms faced with restrictions on production, marketing, or sales are unlikely to believe that they are fair, although a case can be made that they produce a uniform result and thus are fair to consumers. Sources are not likely to consider such bans as fair without very compelling evidence of risk, since they will have considerable "sunk costs" invested in the products. However, a case can be made that they produce a uniform result for consumers in that no one has access to them.

Product bans are typically reserved for cases when the potentially negative impacts of a particular single-purpose product are known to be large, such as with spraying a particular pesticide, using lead paints, or allowing use of a product that becomes hazardous upon disposal. In these instances, simply banning the product is a quick way for the government to provide protection with a reasonable degree of *assurance of meeting goals.*

▽ Technology specifications

Technology specifications are not implemented to achieve cost-effectiveness across firms. Requiring all sources to use identical equipment or placing uniform restrictions on techniques obviously constrains opportunities for firms to seek least-cost solutions. In addition, requiring all firms to solve problems in an identical manner, despite such meaningful differences as location, technological capacity, and marginal abatement costs, is unlikely to be considered fair. These standards are seldom used and the evidence suggests that technology specifications are not adopted with efficiency in mind. They could only be considered fair in the sense of treating all sources the same.

Harm-based standards

Because **harm-based standards** are controlled on a source-by-source basis, they are only average in comparison to other instruments on cost-effectiveness, even though they allow firms or facilities to choose the means through which they comply. Firms are free to adopt new technologies to improve their productivity, costs, or environmental performance, yet there is no specific incentive for firms to do so.

In addition, the administrative burden for government is relatively high. (See the following section on demands on government for more detailed discussion of this issue.) For example, the analytical work required to establish harm-based standards is usually very demanding and resource intensive. Also, monitoring requirements for harm-based standards are more extensive than for other instruments.

With a harm-based standard, the ambient condition of the environment typically determines the ultimate emissions limit that all sources will face (e.g., tons per day out of the pipe, averaged over a 24-hour period).[8] On the one hand, since a harm-based standard is defined by what is good for human health or the environment, it treats all sources the same and, in that sense, may be considered fair. On the other hand, precisely because sources across industries are typically very different, some industries may believe that in a particular instance harm-based standards place a disproportionate burden on them in comparison to other industries. Firms can make a decision to shut down a facility in an area or move to another location to escape onerous standards in a particular area, but they may not save enough to make the move worthwhile.

The fact that sources are given the flexibility to meet a harm-based standard in whatever manner they choose may seem fair to industry. This is because firms value the increase in flexibility and slight decrease in government involvement in their facilities as a good thing, independently of the implications for efficiency.

Design standards

Design standards are usually based on a model technology or technologies, but are often expressed as emission limits. Thus, firms have some flexibility to meet the emissions level or to adopt the model technologies or an "equivalent" technology.

The original purpose of design standards was to require regulated entities to improve their pollution reduction technologies continuously, in part to provide markets for new technologies, but the reality has been that once a facility complies with the standard, there is no specific incentive to do anything more to save money (227), unless innovations with much improved performance or cheaper costs become available. In those cases, firms might adopt those innovations if the transaction costs of changing technologies were not prohibitive.

Since production and treatment technologies may differ across firms and facilities even within an industry, design standards may constrain a regulated entity's choices and thus reduce some opportunity for cost savings.

Design standards typically place a moderate to heavy burden on government for establishing the standards. Moreover, since they are typically implemented uniformly across similar firms, design standards are regarded as unfair because they ignore the current level of pollution, differences in

[8] In contrast, for a design standard the technological capability of the source type determines the kind of emissions limit (e.g., parts per million, maximum concentration level, no averaging).

facility designs, and often widely varying costs of control.

It is doubtful, however, that design standards have ever been utilized with efficient and fair use of resources as the primary concern, except to the degree that they incorporate balancing tests such as "achievable," "feasible," "available," etc. They are typically implemented because the government can define what it wants, at least as a minimum requirement, and they are comparatively easy to enforce.

Pollution charges

A **pollution charge** has long been advocated by economists as having the greatest potential for cost savings, both for industry and government. However, the use of charges as an instrument to force pollution abatement, rather than to raise revenues, has not been widely adopted anywhere.[9] Moreover, the hope that a charge can be based on an individual source's marginal damages at the optimal level of pollution or emissions in relation to the environmental goal is probably impossible for an agency to realize.

The open-endedness of charges does offer a "second best" type of efficiency by providing firms the discretion to determine how to reach as cheaply as possible the level of pollution discharges it decides it must. Depending on how the program is established, the open-endedness could also provide an incentive to continue to reduce discharges, at least up to the point at which it would be cheaper to prevent or control pollution than to pay the charge.

The analytical burden to government of this approach could be relatively moderate, especially if the pollution charge is technology based and remains fairly static. The more frequently the government decides to adjust the charge upward to keep pressure on firms to reduce emissions, the more analytically and politically difficult the charge program would become. In addition, as mentioned earlier, firms are not likely to consider it fair to pay for investments to meet the environmental goal and continue to pay for discharging the residual pollution.

Charges used to reduce solid waste, through making it very expensive for corporations or citizens to dispose of wastes (e.g., per-bag fees), are typically designed both to raise revenues and to change behavior. These kinds of charges, set through some sort of percent reduction targets, may be relatively inexpensive ways for society to induce desired behavior.

Liability

Theoretically, **liability** provides a rough signal to a firm of the costs of exceeding desirable pollution levels. Since liability provisions only require action when a party believes damage has occurred (post facto), the ongoing burden for administration of a program is relatively small. However, proving causality for damages may be quite burdensome for a range of the stakeholders. Firms do not always view such provisions as fair because they often have to retain insurance and take actions that are designed to protect themselves financially rather than directing that money toward protecting the environment. The uncertainty about both whether or not damage will occur and whether or not they will actually have to pay for damages in the future can lead sources to overcomply or undercomply, either of which would be inefficient (21).

Subsidies

Subsidies may offer an effective incentive for firms or other entities to adopt abatement measures because they reduce the financial impacts and provide an easy enforcement mechanism for the regulator. Because subsidies by definition are free, they will lower a firm's or municipality's cost to achieve the environmental goal in the short run. However, if the subsidy is restricted to certain methods for achieving a goal, it may not lead to the most cost effective approach from society's

[9] European countries have experimented with pollution charges, although the programs are primarily oriented toward revenue raising.

perspective. For this reason, subsidies might be most cost effective when restricted to use during transitional periods, for example, to speed adoption of new technologies.

The case of the deposit-refund system as a subsidy offers potential for efficient pollution control through the use of self-financing (the deposit) and a reward (refund) for proper disposal. The lowered costs of enforcement and reduced motivation for evasion would offer savings for government.

Demands on Government[10]

Demands on government concern the costs and administrative burdens placed on government by requirements to protect human health and the environment.

One of the most persistent complaints about current approaches to environmental protection is that they require too much involvement by government agencies, costing taxpayers money and often delaying companies ready to get on with the task of improving environmental performance. Rather than simply setting the targets and getting out of the way so that sources can choose the best strategies for meeting the targets, government agencies spend too much time and too many resources deciding what each type of source must do and then enforcing rather than facilitating compliance. According to this view, instruments that use incentives to reward improved environmental performance or rely on voluntary efforts by companies would be much cheaper for government to develop and administer.

Although much of this criticism is directed at the federal agencies, especially EPA, a majority of the oversight, implementation, and enforcement of federally mandated environmental regulations takes place at the state level. Moreover, states have discretionary authority in many areas to go beyond federal requirements. Thus, in comparing how effective the instruments might be at minimizing the demands placed on government, both federal and state governments are considered.

Factors for Comparing Instruments

In order to assess the relative demands placed on federal and state administrative agencies by the set of instruments, OTA uses the following two components:

- costs, and
- ease of analysis.

Costs

Governmental agencies expend considerable resources in the course of formulating and implementing environmental protection programs. The federal government spends more on environmental protection than the states. Yet, over the past 15 years, EPA's budget has decreased, while many of the states have held their expenditures at a constant level or actually increased in some areas (154). In 1992, the federal and state governments spent an estimated 1.8 billion in current dollars on regulation and monitoring activities, or 2 percent of estimated total expenditures on pollution abatement and control in the United States (171).

Even though this is a relatively small proportion of the overall expenditures, differences in the instruments' requirements for analytical support, rulemaking, ongoing administration and implementation, monitoring, and compliance activities suggest opportunities for reducing or reallocating expenditures. Information costs to government for becoming an expert on a particular industrial sector, for example, can be very high; in some instances, these costs may restrict the government's ability to know what it should in order to regulate effectively. Those instruments that must be established through the rulemaking process extract additional resources from the agency in the

[10] Parts of this section are based on T.O. McGarity, "Assurance of Meeting Environmental Goals," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, May 1994; and S.A. Shapiro, "Rethinking Environmental Change: Policy Instruments and Adaptability to Change," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, August 1994.

form of time and preparation of supporting documentation. For example, a major rule may take tens of thousands of pages of documentation, responses from industry and other stakeholders, and even trying to change mistakes in these rules can be a formidable undertaking.

In addition, multiple levels of government may also be involved in administering and enforcing the instrument. Some instruments may require a level of monitoring and enforcement by the state that is expensive for the agency in terms of personnel and documentation. Problems such as variability in processes, equipment malfunctions, and operator errors may compound the cost of monitoring for some instruments. For other instruments, the initial implementation may be relatively simple and straightforward but once in place more extensive enforcement efforts are required.

Ease of analysis

Ease of analysis concerns the degree of analytical complexity an instrument poses for the regulatory agency in translating the congressional goal into actions that sources can understand and implement. When Congress establishes risk goals, the task of determining the level of exposure that poses an acceptable risk to human health or the environment is usually left to the implementing agency. Congress most often states acceptable risk in general terms.[11] Occasionally, however, risk definitions have been quite specific (250). Similarly, when Congress enacts an abatement goal, usually stated in terms of "best efforts" for reducing pollution, the agency must identify those technologies that will satisfy the congressional language.[12]

Instruments used with a risk strategy may require more analytical work and be more controversial because of the scientific uncertainty involved and the need to update the goals continually after they are put in place. Those that are used with abatement strategies may also be resource intensive, but once in place require less continual revision.

Regardless of whether Congress chooses a risk or abatement goal or a mix of the two, EPA must usually complete a range of analyses to characterize the problem posed by the particular process or product and alternative ways to handle that problem. It must also document its analyses in sufficient detail to withstand the rulemaking process or other challenges to come in the implementation phase. Analyses might include scientific studies to establish pollutant pathways, engineering studies which document the best technological, designs, cost-benefit analysis of the potential regulatory impact, and cost-benefit analyses of postimplementation impacts. The uncertainty and/or difficulty of interpreting the technological, economic, scientific, and socio-political data can be daunting for regulators. At a minimum, analytical complexity can prolong the period required for translation, provide opportunities for challenges to the agency's efforts, and increase the opportunities for errors in translation.

The credibility and certainty of the supporting analytical work and documentation, the level of institutional resources committed to implementation, resistance by regulated entities or the public,

[11] Examples of this type of statutory goal include setting National Ambient Air Quality Standards (NAAQS) at a level that *protects the public health with an adequate margin of safety* [42 U.S.C. § 7409(b)(1)]; setting standards under the Clean Water Act that *protect the public health and welfare with an ample margin of safety* [33 U.S.C. § 1307(a)(2)]; prohibition in the Resource Conservation and Recovery Act (§ 3004) on the disposal of untreated hazardous wastes in land disposal facilities as long as the wastes remain hazardous, unless EPA approves a method that will be *protective of human health and the environment* [42 U.S.C. § 6924(g)(5)].

[12] For example, the Clean Water Act requires sources of listed toxic water pollutants to meet effluent limitations based upon the *best available control technology economically achievable* [33 U.S.C. § 1311 (b)(2)(A)]; the Clean Water Act and the Clean Air Act provide for standards reflecting *best efforts for new sources of pollution* [33 U.S.C. §1316 (best available demonstrated control technology); 42 U.S.C. §7411(a)(1) (best adequately demonstrated control technology)]; The 1990 Amendments to the Clean Air Act require EPA to promulgate standards for new and existing sources of listed hazardous air pollutants reflecting the *maximum degree of reduction achievable* [42 U.S.C. §7412(d)(2)].

TABLE 4-6: Demands on Government

	Fixed Target: Single-source				Fixed Target: Multisource			No Fixed Target				
	Product bans	Technology specifications	Design standards	Harm-based standards	Integrated permitting	Tradeable emissions	Challenge regulations	Pollution charges	Liability	Information reporting	Subsidies	Technical assistance
Demands on government		•	•	•	V	•	•	•	•	●	V	•
Costs		•	•	•	V	•	•	O	•	•	●	V
Ease of analysis		V	•	•	V	V	O	O	V	•	•	•

● = Effective O = It depends V = Use with caution • = Average

NOTE: These ratings are OTA's judgments, based on theoretical literature and reports of instrument use. The evaluation of each instrument on a particular criterion is relative to all other instruments. Thus, by definition most Instruments are "average. " "Effective" means that the Instrument is typically a reliable choice for achieving the criterion "It depends" means that it maybe effective or about average, depending on the particular situation, but it is not likely to be a poor choice And '(use with caution" means that the instrument should be used carefully if the criterion is of particular concern.

SOURCE: Office of Technology Assessment, 1995.

and the opportunities for administrative, congressional, and judicial review are all factors with the potential to affect whether or not a particular instrument is implemented in a successful and timely manner.

Summary of Instrument Performance

- ● ***Effective: Information reporting***
- O ***It depends: Challenge regulations***
- V ***Use* with caution: *Harm-based standards, subsidies***

All of these instruments place primary responsibility on governmental agencies for the successful outcomes, although they vary considerably on the extent to which the agencies actually use their own resources to accomplish various program components. On a comparative basis, the one requiring the least from government agencies is an information reporting program (see table 4-6). The agency must flesh out the design and protocols of the program, but the implementation of the program essentially shifts to sources.

Challenge regulations also offer the potential for shifting responsibility for most of the implementation to the sources, thus reducing demands on governmental resources. However, our relative inexperience with implementing challenge regulations makes the potential gains in reducing governmental burdens somewhat unpredictable. Nonetheless, OTA expects that with challenge regulations, industries will assume more responsibility for design and implementation, thus alleviating some of these costs for government.

Tradeable emissions have the potential to reduce burdens. However, with RECLAIM, the front-end costs of the analytical work and program design have been very high (see chapter 2 case study). More experience with a variety of trading programs may reduce these types of costs.

We recommend using **harm-based standards** with some caution if the primary concern is reducing the burden on governmental agencies. Although harm-based standards have been heavily used, primarily because of their effectiveness for assurance of meeting goals, their analytical and implementation requirements place very high demands on government.

One of the long-term goals for **integrated permitting** is to reduce the burden on facilities and on the state permit writers. Yet, in the near-term, the level of work required by state agencies in developing an integrated permit for each facility can be daunting. Also, while the concept of multimedia coordination through the permit process is attractive, the scientific and practical information and expertise essential for such decisionmaking is not fully developed.

Liability, if never invoked, is not terribly burdensome for government. But once an agency must develop an action against a firm, the costs and analytical demands can be very large, as demonstrated by the efforts to pursue liability for the Exxon Valdez case. In contrast, **subsidies** might not require much in the way of analysis or implementation but require direct outlays from the treasury. If lower cost to government is the criterion, subsidies should be used with caution.

Instrument-by-Instrument Comparison

● Information reporting

Information reporting is relatively inexpensive for government to implement because the primary burden for information gathering and reporting rests with sources. Government may or may not decide to take an active role in disseminating the information since the primary purpose of such programs is to induce companies to reduce emissions rather than face disclosure of what might seem large releases of pollutants.

The analytical demands of conceptualizing and designing the program adequately to accomplish the desired goal are at least as difficult as the analytical requirements for designing programs utilizing some of the other instruments—that is, they pose a moderate burden. However, the fact that the program then gets handed to sources for ongoing implementation makes it a particularly attractive instrument from the perspective of lowering government costs and implementation responsibilities.

○ Challenge regulations

Because experience with programs similar to challenge is limited, predicting the impact on use of governmental resources is difficult. However, **challenge regulations** could be very effective at reducing barriers to implementation by moving toward cooperative or negotiating processes for establishing implementation activities such as benchmarks and timetables.

Depending on how the particular challenge regulation is designed, however, it could easily end up changing the nature of the administrative activities in some ways without actually reducing the burdens. If the ultimate goal is a harm-based one, for example, the agency is likely to complete the same difficult analytical tasks it would have with a harm-based standard. On the other hand, if the goal is technology based, then the analytical task may be somewhat easier. It is possible that, even with a risk goal, the working relationship among sources, interest groups, and the government could be collaborative enough to make the overall task easier; but without some experience this kind of scenario is speculative.

▽ Harm-based standards

Harm-based standards, typically expressed as a media quality goal, depend on complicated models of performance and require more complex monitoring in order to establish significant progress. The level of scientific and technological expertise needed and the uncertainty typically present for setting or revising a harm-based standard requires considerable administrative resources.

The initial task of translating statutory language into a particular concentration of a pollutant in the receiving medium is exceedingly difficult. Methodologies are not sufficiently well developed to allow agencies to specify with a great deal of accuracy the degree of health and environmental risk posed by various concentrations of a toxic pollutant in a receiving medium (95,112). In addition, the value-laden questions and methodological uncertainties surrounding existing risk-assessment techniques reduce the credibility and confidence that stakeholders can place in the agency's media quality goal as an equivalent for the established acceptable risk goal (101, 112,130).

Media quality goals in some cases are delegated to the states for implementation. At that point, states often develop source-by-source harm-based standards in order to be able to write permits for facilities spelling out the allowable emissions levels. In fact, sources themselves often seek this protection—as long as they are in compliance with their permit, they can not be held liable if the state does not meet its media quality goal.

Harm-based standards are also subject to executive and judicial review. For example, although only one relatively minor aspect of the original 1971 National Ambient Air Quality Standards (NAAQS) was challenged in court, every subsequent attempt to revise those standards or to write standards for new pollutants has been the subject of intense executive review (114,119) and later judicial challenges (132).

▽ Subsidies

Subsidies are obviously very costly to government because they require direct outlays. Thus, if reducing costs to government is a primary consideration, subsidies should be used with caution. The analytical difficulty of designing a subsidy program should not be particularly burdensome. And since implementation of the program would be shifted to firms participating in the subsidy program, the government would have minimal responsibility for activities other than evaluating the implementation by sources to ensure that they were meeting the program goals.

Product bans

Although **product bans** are only about average in overall demands placed on government in comparison to other instruments, completing the analytical work to justify their use can be quite demanding. Because of the implications of interfering with commerce, those choosing bans will want to have incontrovertible proof that such products pose serious health or environmental risks. However, barring a very dramatic causal episode, such information is usually quite time-consuming and costly to develop.

Technology specifications

Technology specifications are rarely used and when they are, Congress usually specifies the standard. This greatly reduces the political analytical efforts associated with design standards as well as the costs. The primary burden for governmental agencies is in the implementation phase, especially the permitting and enforcement aspects.

Design standards

Most **design standards** are associated with an abatement or a "best efforts" goal and can be recognized by the alphabet soup descriptions, such as BACT (best available control technology), BAT (best available technology), BPT (best practicable technology), LAER (lowest achievable emissions rate), MACT (maximum achievable control technology), etc. When Congress mandates that new sources in nonattainment areas meet the lowest achievable emissions rate or when it requires new and existing sources of toxic air pollutants to install maximum achievable control technology, it is establishing the framework in which sources must use their best efforts to reduce emissions of the relevant pollutants. The language allows individual sources the flexibility to achieve the same degree of pollution control by other acceptable means, but the processes of demonstrating equivalency or obtaining waivers not only place demands on sources but on government resources as well (113). The benefits of this flexibility are discussed in the section on *cost-effectiveness and fairness to sources*.

Instruments associated with technology-based strategies such as BAT are usually less complicated to establish and the results less complicated to measure than those associated with risk-based strategies; but they are nonetheless moderately difficult. To support and document its decisions about abatement technologies, the agency must study the industries' production processes, product and waste streams, facilities, control technology costs, and other factors that appear relevant to the agency and its engineers. In order to select a model technology capable of reaching the abatement goal, the agency must incorporate economic judgments as well as engineering judgments, yet the technological feasibility of reducing emissions of pollutants is the *primary* consideration. Finally, the agency establishes pollution limits designed to induce dischargers to implement the specified control technology or any other technology or practice capable of achieving the same degree of pollutant reduction.[13]

If an agency attempts to use design standards to achieve a very ambitious abatement goal, it may have difficulty developing a record capable of supporting its prediction that the model technology is capable of achieving a particular level of performance. If EPA proposes to press technology in the slightest, it must engage in a leap of faith that the model technology will reach a generic effluent limitation in all regulated contexts. The agency often has a difficult time persuading reviewing institutions, such as the Office of Management and Budget (OMB) and the courts of appeals, to take the same leap of faith (3,113).

Agency efforts to write design standards for existing sources of pollution may encounter resistance from the owners of those sources and their employees. The model technologies used in most design standards are often capital intensive, and the investments in pollution control are generally not offset by increased profits (7). However, there is no reason that pollution prevention approaches cannot be used as the model technologies, with more capital-intensive end-of-line technologies being allowed as substitutes if their performance is equivalent.

Since design standards are nearly always challenged in court, the agency must be prepared to meet every conceivable technical and legal objection to its standard-setting initiative before it issues the final regulation. The possibility of judicial review continues to influence agency administrative practices, adding to the level of resources allocated to documentation.

Integrated permitting

The most common arguments for **integrated permitting** are its potential to reduce the administrative efforts for both the sources and the governmental agencies in issuing and revising facility permits. However, to date, rather than reducing the overall government burden, they may have actually increased the burden in the short-term as facility managers and government officials gain experience in writing these types of permits and implementing them (149). Thus, if the primary criterion is reducing the burden on government, it is important to recognize that at least initially, agencies may actually have to dedicate a higher level of resources to implementing this instrument.

One advantage of these permits may be in reducing the complexity and costs of monitoring and enforcement. Being able to approach a facility as a whole with better understanding of its overall strengths and weaknesses for emission problems may improve overall efforts to detect violations and develop plans for improved monitoring capability.

Another advantage associated with the concept of integrated permits is their potential for incorporating multimedia tradeoffs. A few efforts in Minnesota, New Jersey, and Wisconsin have indicated that this approach has potential for using a multi-

[13] Examples of the technology-based approach include "best available technology" and "best conventional technology" effluent guidelines and limitations promulgated under section 301 of the Clean Water Act; new source performance standards promulgated under section 306 of the Clean Water Act and section 111 of the Clean Air Act; "best available control technology" for new sources in clean air areas promulgated under section 165 of the Clean Air Act; "lowest achievable emissions rate" requirement for new sources in nonattainment areas promulgated under section 173 of the Clean Air Act; and "best demonstrated available technology" for treatment of hazardous wastes under section 3004(m) of the Resource Conservation and Recovery Act.

media framework in tackling pollution reduction by facilities. These initial experiments have required considerable investment of resources by state agencies and have been analytically complex, although state officials with experience in working with these permits are optimistic about their potential (149).

Tradeable emissions

One of the key arguments for using **tradeable emissions** is that they will greatly reduce the role of government. Although we do not yet have enough experience with this approach to evaluate fully how much they reduce the level of governmental involvement characteristic of other approaches, thus far trading programs have required considerable efforts by governmental agencies. For example, the initial allocation of allowances or permits and the schedule of reductions has been contentious.

However, when government is determined to make something work, as in the case of the RECLAIM tradable emissions program for NO_x and SO_2, it can concentrate resources effectively. What might have been close to a decade of rulemaking was condensed into two years. However, the time and effort invested in designing the program over those first two years was extraordinary.

Critics have objected to the delays introduced by trading programs requiring pre-approval of proposed trades by agencies. Current efforts to establish open markets stem in part from frustration over the implementation difficulties that have slowed other trading efforts (16). As conceptualized and implemented to date, these trades do not require prior approval from government officials and do not require revisions of state implementation plans (SIPs), thus minimizing the delays encountered when waiting for government approval. However, many issues such as inter-pollutant trading and cross-regional trading are beginning to emerge. Taking time to resolve these may slow the programs down.

Thus, while trading programs may introduce flexibility for sources and encourage more cost-effective ways for sources to reduce pollution, concern over other criteria such as *assurance* and the *equity and justice* of the outcomes of trading choices for various areas suggests the need for care in designing and implementing trading programs. Weighing these concerns will require continuing involvement by federal and state agencies.

Pollution charges

Pollution charges are likely to place moderate burdens on governmental agencies—much less than harm-based standards but considerably more than information programs. After all, the United States has considerable experience in administering tax programs at all levels of government. Yet the potential for political difficulties in initiating and revising “taxes” on pollution discharges suggests the potential for at least a moderate level of administrative effort by agencies responsible for the programs.

The uncertainty of predicting the impact of a particular charge on receiving media (7,123,186) is perhaps the greatest analytical demand in using this approach to meet goals. Determining the optimum charge under a risk-based strategy can be very difficult for an agency and requires continuous monitoring and adjustments to keep the fee at the desired level. The agency must predict how individual companies will react to a charge, translate that prediction into an estimated reduction in the pollution load, and determine whether that reduction will result in acceptable media quality. Given sufficient regulatory patience, the appropriate fee can be determined by trial and error, but political and administrative efficiency considerations generally preclude that strategy. Environmental groups are likely to object to an iterative process that begins with a modest fee and works upward. Pollution sources can be expected to resist vigorously a process that works in the other direction, arguing that once pollution controls have been installed or manufacturing processes changed it is small consolation when the fee-setting entity acknowledges that it overshot the acceptable risk mark (7,156,160,161).

If the environmental goal is to achieve a specified level of environmental quality, continuous monitoring would be needed as new discharging facilities are constructed and existing facilities expanded, and the charge adjusted when the overall pollution load increases (57,160,220). A constantly changing charge might generate considerable administrative costs and political opposition (123,160,220). However, these difficulties might be offset by the ease of enforcement once the system is in place.

Liability

Since **liability** defines the consequences of environmental damage, it theoretically places little burden on governmental agencies until damage actually occurs. At that point, the burden for agencies to characterize and estimate the damages, costs for remediation, and support the legal work required to make a successful case are substantial. Moreover, when they win the case, it affects just that one company. Although it serves as a warning or deterrent, devoting similar efforts and resources to create a general rule or regulation might have a more certain effect.

Technical assistance

Technical assistance, depending on how a program is designed, is about average on the level of demands placed on government. These programs can vary widely in form, ranging from direct service delivery by the states or federal government to contracted service arrangements. They may be hands-on assistance provided through site visits or the design and maintenance of databases on technical issues or technologies.

However, since they do not require the government to regulate, monitor, or enforce fixed targets for pollution reduction, technical assistance programs place relatively moderate demands on agencies. In addition, they currently represent a relatively small proportion of the resources committed to environmental protection policies.

CHANGE

Almost all parties involved in environmental issues express a desire to improve their capacity to encourage and take advantage of new technological capabilities that can improve environmental protection. Yet, both industry and government often express frustration at the complexity and lack of responsiveness to **change** that characterize the decisionmaking processes.

Sometimes, having to proceed slowly may be what we intended to accomplish. For example, the Administrative Procedure Act (APA), the proposed congressional "waitover" period, legislative veto, and mandate for risk assessment all encourage deliberation before action to protect the rights of those affected by government actions. And when choosing instruments for implementing policies, we often bet on a "sure thing," even though it may restrict opportunities to learn about new technologies or to respond to new information about environmental risks.

Yet in a world dominated by increasing complexity and uncertainty, there are many advocates for making environmental policy both easier to change and more responsive to change. The following two sections discuss **adaptability** and **technology innovation and diffusion**, criteria that capture this interest in creating a future-oriented policy framework that both encourages and accommodates change.

Adaptability[14]

Adaptability considers how easily the policy instruments, once implemented, can be modified, either by government or by regulated entities, to accommodate new scientific information or abatement capability.

A key criticism of current approaches for protecting the environment is that they are not very adaptable to important and rapid changes in the base of scientific information or technological capabilities (49,54,163). According to this view, the

[14] Parts of this section are based on S.A. Shapiro, "Rethinking Environmental Change: Policy Instruments and Adaptability to Change," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, August 1994.

only sensible way to address the uncertainty associated with complex environmental policies is to use instruments that give government agencies and sources the needed flexibility to adapt to changing circumstances and to learn from experimental efforts.

Critics believe the policy instruments we typically use unnecessarily restrict options for effective solutions. Companies express frustration, for example, at their inability to make even minor product or process changes to improve performance and maintain competitiveness without seeking administrative approval for variations—no matter how slight or temporary—from environmental requirements. Government officials are similarly frustrated when innovative policies they wish to support are blocked by statutory restrictions or the objections of special groups.

However, when tradeoffs between adaptability to change and other public values have emerged, policymakers have sometimes given adaptability the back seat. For example, they may decide that they are more interested in assuring a high level of protection from hazardous waste storage and in providing opportunities for full public participation in siting decisions than in using an approach that might be easily adapted to changing information.

Once the level of protection is in place, federal and state agencies have often been reluctant to reopen such a decision because of the institutional difficulties of modification. In addition, some companies may prefer a high degree of certainty over adaptability in situations where a rule or regulation protects their investments or enhances their competitiveness. However, if policymakers agree that the capacity to accommodate change is desirable, then basing the choice of policy instruments on a strategy that is either not likely to require modifications or is relatively easy to modify makes the most sense.

This section evaluates the difficulty or "marginal grief" for government of modifying a particular instrument. It also assesses the extent to which a targeted entity has some autonomy to adapt its responses to changes that affect its environmental performance without waiting for approval from a regulatory agency.

Factors for Comparing Instruments

The two major sources of change that trigger a need to modify policy instruments are a change in the perception of risk from a pollutant or activity or a change in abatement capability. A change in risk perception typically comes from new scientific information or from changing interpretations of existing information. Both can affect the assumptions of an underlying risk assessment or cost-benefit analysis by demonstrating that a pollutant poses a greater or lesser risk than was previously understood. A revised risk assessment might suggest that a different level of risk is socially appropriate.[15]

Pollution abatement innovations can affect environmental regulations by producing techniques that are less expensive to install and/or utilize than existing technologies or that are capable of greater pollution abatement. Ideally, technologies offering lower costs or improved capacity could be readily adopted by firms without agency intervention if the changes could improve their overall performance.

Since both types of change are inevitable, all policy instruments would ideally be either unaffected or easily adaptable. However, the potential administrative and political constraints involved in revising a regulatory decision may make it difficult for policymakers to achieve such adaptability in every circumstance. Nonetheless, if adaptability to change is a priority, policymakers can choose and use instruments strategically to im-

[15] For example, new information on risk pathways indicating greater risks from pollutants than previously understood might trigger reevaluation of acceptable risk levels. Also, the public's willingness to accept risks from a particular activity might change even though scientific knowledge about such risks has not changed. For example, such knowledge may simply become more widespread or the public may perceive the benefits from the activity as diminishing or becoming less important in comparison to perceived risks.

prove their overall performance in achieving this criterion.

The simplest way to ensure adaptability is to use a strategy and instrument combination that remains, as much as possible, unaffected by such change. For example, since harm-based standards are tied to risk, sources have complete flexibility to respond to favorable changes in cost, availability or new capability in abatement technologies without waiting for a revised standard.

Similarly, when the perception of risk changes, it may not be necessary to modify a technology-based standard, such as a design standard, especially if no significant changes in the performance of technologies have occurred. If, given the current state of technology, overcontrol is not likely to be a problem in the near future, then sidestepping the need to justify a risk-based standard for each pollutant has advantages.

Nevertheless, sometimes change makes modification of the instrument itself desirable. The ease of such change depends more on the decisionmaking procedures required, in particular those associated with the administrative decisionmaking requirements and congressional and judicial review requirements than on any inherent characteristics of the instrument. These complex procedures usually apply to those instruments that require sources to take specific pollution reduction actions. Thus, there is often a tradeoff between improving performance on *adaptability* to change and maintaining *assurance of meeting environmental goals*.

Before comparing each of the instruments, the sections below explore two factors important for assessing adaptability to change:

- ease of program modification, and
- ease of source changes.

Ease of program modification

Policy instruments vary in the degree of difficulty for the regulatory agency in completing the steps required for their modification. Some believe that even the most inherently adaptable of instruments is likely to become difficult to modify once it is embedded in the current institutional configuration of agencies and decisionmaking processes for environmental policymaking (95).

EPA is required by both statutes and Executive Orders to evaluate risks to health and the environment and to consider the feasibility of alternative solutions for reducing those risks (231,251,257). When EPA modifies an instrument, it must identify and resolve the scientific, engineering, and legal issues that the changes have raised. Because EPA employs a relatively small number of scientists, engineers, and economists capable of undertaking rigorous scientific and policy analyses, the number of difficult projects that the agency can undertake at any given point in time is limited.

The legal and procedural requirements of the Administrative Procedure Act, while providing important guarantees for due process to sources and agency accountability to the public, nonetheless can restrict EPA's ability to respond to changes in a timely manner. In addition, instruments for which a large number of waivers must be individually handled can also be resource intensive.

Ease of source changes

For many firms, the ability to make product or process changes quickly can be essential for competitiveness. Having to wait for decisions by administrative agencies regarding permit modifications or waivers can be frustrating, especially when the facility managers believe the impact on environmental performance will be nonexistent or negligible.

Continuous, incremental innovations are often the lifeblood of companies in highly competitive industries. Giving these industries the flexibility to adapt how they meet goals without having to seek preapprovals from an agency official before acting on process or product modifications could spur improvements in technologies and increase opportunities for the most cost-effective solutions.

TABLE 4-7: Adaptability

	Fixed Target: Single-source				Fixed Target: Multisource			No Fixed Target				
	Product bans	Technology specifications	Design standards	Harm-based standards	Integrated permitting	Tradeable emissions	Challenge regulations	Pollution charges	Liability	Information reporting	Subsidies	Technical assistance
Adaptability	∇	∇	∇	•	•	•	O	•	●	●	•	●
Ease of program modification	∇	∇	∇	∇	∇	∇	•	∇	●	●	O	●
Ease of change for sources	∇	∇	∇	•	O	●	●	●	●	●	•	●

● = Effective O = It depends V = Use with caution . = Average

NOTE: These ratings are OTA's judgments, based on theoretical literature and reports of instrument use. The evaluahon of each instrument on a particular criterion is relative to all other instruments Thus, by definition most instruments are "average." "Effective" means that the instrument is typically a reliable choice for achieving the criterion. "It depends" means that it maybe effective or about average, depending on the particular situation, but it is not likely to be a poor choice And "use with caution" means that the instrument should be used carefully if the criterion is of particular concern.

SOURCE: Office of Technology Assessment, 1995

Summary of Instrument Performance

- ● **Effective:** ***Liability, information reporting, technical assistance***
- O **It depends:** ***Challenge regulations***
- v **Use with caution:** ***Product bans, technology specifications, design standards***

Two general conclusions about adaptability emerge from a comparison of the policy instruments. First, almost all of these instruments are difficult for an agency to modify primarily because of administrative complexities associated with rulemaking and the potential for congressional and judicial review. And second, if policymakers anticipate and want to accommodate certain kinds of changes, they could choose those instruments that would be most resilient or least affected by the expected changes.

Instruments tightly wedded to either a risk- or technology-based strategy—such as harm-based standards or design standards-almost always have to be modified when faced with changes from that particular source (see table 4-7). Exceptions—liability, information reporting, technical assistance, and depending on the particular program provisions, challenge regulations—tend to be tied to broad strategic goals rather than to specific models of acceptable risk levels or performance of technologies. In addition, several of these instruments can be relatively easily modified without rulemaking or adjudication, using agency discretion after consultation with stakeholders. Of course, major changes in the statutory basis for any of these programs would require congressional action.

If policymakers expect and want to accommodate changes in abatement capability but also want to limit pollution, using a harm-based standard provides a context in which technological changes have the least effect. Sources are free to adopt the technology or not and the agency does not have to rewrite instruments to incorporate the new capability. For example, if a tradeable emissions program is established with a risk-based cap on emissions, a firm can decide whether or not to adopt any changes in abatement capability, without an agency having to rewrite regulations.

This same type of tracking occurs for instruments associated with risk-based strategies. Harm-based standards, tradeable emissions, and perhaps challenge regulations would typically have to be modified if knowledge or public perception related to their particular goals were to change significantly. For example, if the tradeable emissions program's risk-based cap is now believed to be inadequate to protect human health, then the overall harm-based standard or emissions cap for the area would have to be rewritten.

Design standards, technology specifications, integrated permitting, and pollution charges would be much less affected since they are not usually as tightly linked to acceptable risk levels. However, even technology-based instruments may have to be modified if new information about risks makes decisions about what is achievable, practicable, or available no longer seem valid. Most policy instruments under this strategy face some sort of balancing test about what constitutes the state of abatement capability.

Instrument-by-Instrument Comparison

● Liability

Although Congress normally defines **liability** through individual statutes, once that regime is in place it is generally able to respond to changes in new information or abatement capability through interpretations by the agency and the courts rather than through statutory revisions. New scientific information could suggest, for example, that a pollutant posed previously unknown risks. If this were the case, it would improve the ability to establish a causal link between the discharge and the damage it caused. The information would be presented as part of the case against the polluter.

Firms are able to make pollution abatement choices based on their own needs and evaluation of risks. Thus liability is effective at leaving firms free to respond and adapt to new information and capabilities.

● Information reporting

Information reporting is highly adaptable because once such requirements are imposed, their value does not depend on marginal changes concerning what risk exists or what level of risk is appropriate. A source's obligation to tell EPA or the public how much of a pollutant it emits is unaffected by changes in the perceived level of risk that pollutant presents except in the unlikely circumstance regulators decide that the pollutant is no longer dangerous. However, an obligation to report to the public the known dangers of a pollutant might be affected by new scientific developments about its impacts. The agency might have to reformulate the reporting program to convey this new information and, of course, the sources would have to adapt their reporting accordingly.

● Technical assistance

These programs are usually unaffected by specific changes in risk perception or new technologies. EPA's choices concerning **technical assistance** are normally exempt from rulemaking as a "policy statement" or "a rule of organization" (277). If new scientific developments or a change in political priorities leads to a decision to scrap one of these goals, the entire assistance program might have to be reformulated to achieve a different goal. But it would take a dramatic shift in scientific information or political priorities to merit scrapping an assistance program altogether. Such a change is more likely to cause Congress, or EPA if it had the necessary discretion, to change the resources committed to these instruments.

○ Challenge regulations

The adaptability of **challenge regulations** probably depends on how the program is developed, although the potential to change such programs appears to be easier than for most of the other instruments. For example, if long-term targets are based on a consensus of stakeholders, the basis exists for accommodating new information relatively easily. However, if there are significant differences among interested parties about the level or timing of targets, pressure for modification of the program may emerge in the face of new information or capability.

Changes in risk perception pose the most difficult issue for challenge regulations. Those sources attempting to comply with the original target could be expected to oppose a new target, especially if they have already relied on the old goal by investing in a particular abatement approach. Indeed, a change by EPA in the target might cause the sources to end their compliance efforts altogether.

▽ Product bans

Product bans and limitations are generally used only after a regulator determines that existing scientific information indicates that a product poses sufficient risk to justify total or partial prohibition of its use. Product limitations are usually established through regulations, while some bans have been established by Congress (e.g., CFCs). Thus, efforts to modify them would not be easy, requiring rulemaking or legislative action.

New abatement capability such as better product substitutes or better control technologies might not require the agency to change harm-based bans or limitations. Industries would be able to adopt these new capabilities according to their own needs. However, if product limitations are put into place based on technological capability or the available of adequate substitutes, then new capabilities might be sufficient to justify reopening the restrictions.

▽ Technology specifications

Although seldom used, **technology specifications** would have to be completely reformulated to accommodate improvements in abatement capability. Otherwise, firms adopting the new technology would risk being out of compliance. Changes in technology specifications may face serious challenges from sources because they dislike such specifications intensively and already have "sunk costs" in existing technologies.

Changes in risk perception would generate the same kind of uncertainty about modification as design standards. That is, if a "balancing" test has been done to determine the feasibility of a particular technology, then new information or perceptions about risk might change the outcome of that calculation.

▽ Design standards

A **design standard** gives sources the option of adopting the technology specified in the regulation or another that "performs like the model technology." Sources might take advantage of this option if new control technologies were marketed that were less expensive. EPA would have to verify that the new technology performs like the model, but it would not have to reformulate its standard. A source would not have the same incentive to adopt a new technology if it were more expensive, even if it would reduce emissions more than its existing abatement method. In this case, EPA might decide to reformulate its design standard to force sources to adopt the new technology.

The model technologies approach does permit firms some discretion to seek approval for a different design on a case-by-case basis. Such approvals provide the opportunity for firms to use innovative technologies. Although any particular case might not be as difficult as a rulemaking, resolving technology choices on a firm-by-firm basis could be burdensome (see the section on *cost-effectiveness and fairness*). Design standards modifications must be made through the rulemaking process, making them vulnerable to the usual delays and challenges.

When abatement capability changes, design standards established for a risk-based strategy, such as a backup to harm-based standards, might remain unaffected and allow firms the choice about whether or not to adopt the new capability. The agency might decide to modify the standards for new sources. If the design standard was written as a technology-based strategy to characterize the state-of-the-art technology, then the agency would eventually have to modify the standard, particularly for new sources. However, if a balancing test is required by the statute, then the agency would have to reconsider that test to determine the model technology.

Harm-based standards

Modifying a **harm-based standard** is never easy because the agency must use the rulemaking process. The analytical complexity and likelihood of contentiousness by various stakeholders will depend on the nature of the new information. A harm-based standard would not have to be rewritten to accommodate new abatement capability. Sources would be free to take advantage of the new abatement capability, and they might do so if it is cost effective. In fact, given the choice between a design and a harm-based standard, sources usually prefer the latter because they have flexibility to design and implement the means for compliance.

If a change in risk perception occurs that suggests that current standards are not adequate, then a harm-based standard would probably have to be rewritten. If the analytical work required to support the original standard is considered sound, then much of the agency's modeling work can be used to recalculate the appropriate new standard. However, even with that step simplified in comparison to the original standard setting, going through rulemaking requires considerable time and agency resources.

Integrated permitting

Most current efforts to write **integrated permits** involve learning how to do the first ones. It is possible that the complexity of writing these types of permits will result in making changes in any one part more difficult than if a single-medium permit existed. However, it is also possible that once a permit captures the relationships and tradeoffs within a facility, making incremental changes will be easier for sources. The need for modification of the permit will depend primarily on the type of instruments on which the integrated permit is based and the nature of the change.

Tradeable emissions

Tradeable emissions programs are complicated to establish and the prospect of modification once implementation has begun might be difficult politically. However, once the market rules are in place, sources have considerable flexibility to adapt their strategies. Firms would be free to choose the course of action that meets their own strategic interests; firms generally like **tradeable emissions** because of this aspect.

Current efforts to implement tradeable emissions programs (e.g., RECLAIM) suggest that modifying the overall standard for a particular pollutant would be very difficult, although with more experience the difficulties may lessen.[16] When abatement capability improves, an emissions cap based on acceptable level of risk would not have to be modified. However, if the original strategy and allocations were based on an agreement about abatement capability, there might be pressure to modify the program to reflect the new capability.

Proposed changes in tradeable emissions programs might face particularly difficult political resistance. Changing a tradeable emissions regime would probably involve more than the usual amount of oversight and organized interest involvement. Environmentalists would likely oppose an increase in the number of permits, while regulated sources would likely oppose a reduction. The opposition of the latter group might be especially strong because the modification of per-

[16] The experience with RECLAIM has been described as "condensing 10 years of rulemaking into 2 years." Thus, although establishing these kinds of programs looks formidable, future programs may be less difficult.

mits could destabilize market expectations.[17] The possibility of additional trades in emission permits might soften this opposition, but it is unlikely to eliminate it.[18]

Judicial review can also be expected, but it may be more complex than the usual challenge to an EPA decision. Litigants might argue that a reduction in the number of permits constitutes a taking in violation of the Fifth Amendment. Although this argument may not ultimately prevail,[19] resolution of the issue will require a Supreme Court ruling, which would likely take a considerable amount of time.

Pollution charges

Modifying **pollution charges** is probably not easy regardless of the initial strategy used, although setting a new charge based on an abatement strategy might be easier than trying to make changes based on a harm-based approach. Any attempt to establish, track, and iteratively modify charges based on the marginal costs to facilities in order to achieve fairly certain ambient levels of pollutants would be very difficult.

EPA is likely to face more than the usual degree of oversight. The agency is likely to be scrutinized by the tax committees in Congress in addition to committees responsible for environmental protection (22). In fact, there is some question whether EPA even has the authority to set a pollution charge. The Supreme Court has approved the delegation of the authority to set user fees, suggesting that Congress can delegate the authority to set pollution charges as long as it clearly establishes the limits of EPA's authority.[20]

One key difficulty is how bargaining and compromise might occur. A student of the European experience with pollution charges concludes that

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[17] In comparing pollution charges (or taxes) and tradeable permits, Sanford Gaines and Richard Westin note: "Because pollution control entails long-term capital investment, the market will work well only when the total amount of rights can be held stable for many years. If new scientific data require the government to reduce the number of rights unexpectedly, confidence in the market will be undermined. . . . [I]f the amount of acceptable pollution is subject to rapid change, or if regulation of the market becomes necessary to prevent abuses [i.e., wealthy firms buying up rights in order to drive out competition] public policy would favor a tax." S. Gaines and R. Westin, *Taxation for Environmental Protection: A Multinational Legal Study* (New York, NY: Quorum Books, 1991).

[18] Firms with high abatement costs could lower those costs by purchasing additional permits from firms with low abatement costs. Nevertheless, a reduction in permits would increase costs for both sets of firms. Firms with low abatement costs would have to pay for additional abatement, while firms with high abatement costs would have to pay for additional pollution permits.

[19] The Clean Air Act states that SO_2 allowances granted to power plants do not constitute property rights, 42 U.S.C. § 7651 b(f). Whether this statement would bind a court is unclear. The statement should reduce the legitimate investment-backed expectations of the allowance holder, thus reducing the chances of a taking occurring.

[20] In *Skinner* v. *Mid-American Pipeline Co*., 490 U.S. 212 (1989), which concerned fees to recover the costs of inspection of natural gas pipelines, the Court applied the standard that "Congress must indicate clearly its intention to delegate to the executive the discretionary authority to recover administrative costs not inuring directly to the benefit of regulated parties . . . whether characterized as 'fees' or 'taxes' on those parties." *Id*. at 224. In upholding the fees, the Court cited that the agency could only apply criteria set by Congress and could not establish a fee schedule that does not bear a reasonable relationship to these criteria. These restrictions satisfied the nondelegation doctrine according to the Court.

Skinner clarified that *National Cable Television Assn.* v. *United States*, 415 U.S. 336 (1974), did not prohibit the delegation of user fees even if the benefits of such fees were for public purposes rather than for the benefit of the entity that was charged the fees. According to *Skinner*, *National Cable* stands for the proposition that Congress must clearly delegate the authority to charge fees that benefit the public.

United States v. *Rohm and Haas Co.*, 2 F.3d 1265 (3rd Cir. 1993), drew on the distinction made in *Skinner*, when the court overturned EPA's attempt to collect oversight costs at Superfund sites as unauthorized by Congress. Because oversight costs were "'administrative costs not inuring directly to the benefit of regulated parties but rather to the public at large," *id*. at 1273, the court declared, "To the extent that the fee was used to further the benefit of the public, it was more appropriately considered a tax and required explicit congressional authorization." *Id*. at 1274 n. 12.

If Congress *expressly* authorized EPA to collect user fees, it should satisfy *National Cable* and *Rohm & Haas*. Moreover, if Congress "provides [the] administrative agency with [sufficient] standards guiding its actions, no delegation of legislative authority trenching on the principle of separation of powers [will] occur." *Skinner*, 490 U.S. at 218.

"nothing in the nature of a charge makes it immune to the political virus" (168). Another study finds, "Contrary to the expectation of some American economists that a system of charges 'would reduce the scope for administrative discretion and bargaining,' bargaining and negotiations play a major role in the French system" (110).

Changes in abatement capability would not require modifications to pollution charges. If the improved capability would lower payments for a particular firm, then presumably the firm would adopt it. However, if an agency has used payments as a source of revenues, then it may want to consider raising the charge. For example, pollution charges in the form of per-bag fees on household wastes are not set according to a calculation about the level of acceptable risk but rather on the capacity of the system to handle trash and estimates of the customer's willingness to pay.

If the agency is using charges to force firms to reduce levels of pollutants to meet an ambient goal based on acceptable risk, then any changes in risk perception will require the agency to raise the fee to force more reductions. If the charges are based on estimates of the levels that can be reached with the best abatement capabilities, then changes in risk perceptions would provide pressure to reconsider the balancing test or to consider moving to a technology-forcing strategy.

In contrast to the difficulty that EPA might face modifying a charge in response to changes in technology or risk perceptions, sources have considerable freedom to make changes as they see fit. Again, sources might object to the prospect of EPA's making adjustments to a charge, but once a charge is set, the only interaction the source must have with the agency is to monitor and report emissions and to pay the charge.

Subsidies

Subsidies usually provide financial assistance to sources, who can choose whether or not to take advantage of them, with the purpose of stimulating environmentally beneficial behavior. If tax allowances are to be used as the subsidy, Congress would normally establish new eligibility rules (62,143,223). EPA can originate grants and loans only for purposes and amounts legislated by Congress. If EPA has the authority to change subsidies, it can avoid rulemaking under an exception for rules concerning "public property, loans, grants, benefits, and contracts" (230). The Administrative Conference, however, has recommended that agencies use notice and comment rulemaking for these functions (260).

It would take a dramatic shift in new information to change an existing subsidy program and proposed changes would be likely to generate more than the usual degree of legislative oversight. Any such changes would be of interest to any member of Congress who has eligible constituents affected by the proposed changes. For example, the degree of political infighting that surrounds reallocation of grants under the Clean Water Act (such as sewer construction grants) is quite high.

Technology Innovation and Diffusion[21]

Technology innovation and diffusion seeks improved environmental performance—in quality or cost—through changes to or widespread adoption of existing technologies.

Technology innovation and diffusion[22] can be a major source of both economic growth and a cleaner environment. From an environmental perspective, innovation and diffusion offer ways to

[21] Parts of this section are based on G.R. Heaton, Jr., "Environmental Policy Instruments and Technology Innovation," unpublished contractor report prepared for the Office of Technology Assessment, U.S. Congress, Washington, DC, June 1994.

[22] Technology innovation is the first commercial application of a technical idea or method. Innovations can be classified as radical or incremental improvements, depending on the degree of change from the status quo. Although radical or new innovations often receive the most attention, the majority of innovations involve small improvements to existing technologies.

deliver goods and services with less environmental pollution and to provide new ways to trap or clean up pollutants.

Concern persists, however, that environmental regulations may hurt the competitive position of U.S. firms in the global economy by adding to production costs and impeding performance and cost innovations.[23] Examples of the concerns include: 1) regulation-driven costs place U.S. firms at a competitive disadvantage; 2) compliance costs divert money from commercial innovation; and 3) rigid regulations are incompatible with the trial-and-error processes essential for economic success in many technology sectors (89,166,197).

Examples of specific criticisms directed at specific policy instruments include: 1) technology-based instruments favor known technologies; 2) permits create barriers to innovative improvements; and 3) end-of-pipe, media-specific standards restrict innovative process solutions.

Yet when trying to understand exactly how policy tools affect technology innovation and diffusion, we face at least three basic challenges: 1) technology innovation is trying to do what no one knows how to do (87); 2) it occurs within complex and unique institutional arrangements (84, 88,140); and 3) little research is available on the effect of specific regulatory instruments on technology innovation.

We do know that establishing regulations in a way that provides reasonably certain targets and clear timetables reduces uncertainty, making investments in innovation less risky. Further, if innovation is a key purpose, targets and timetables must also put the kind of financial or technological pressure on companies that will stimulate a search for new ways of meeting environmental goals.

While environmental regulations can be important, they are in most cases a relatively small factor among many that firms consider when choosing to innovate (197). This suggests that if technology innovation is a high priority, there may be much more direct and effective ways to encourage it than reforming the particular regulatory instruments used to implement environmental goals.

Factors for Comparing Instruments

In this section, we use three factors for evaluating and comparing the impact of policy instruments on technology innovation and diffusion:

- innovation in the regulated industries;
- innovation in the environmental goods and services (EG&S) industry; and
- diffusion of known technologies.

Each of these categories offers opportunities for furthering technological solutions to environmental problems. Emphasizing one path, however, can sometimes constrain opportunities for utilizing another.

Innovation in the regulated industries

Environmental regulations can have both direct and indirect impacts on manufacturing firms or governmental entities like sewage treatments plants by, for example, creating preferences for a type of technology, generating new markets, raising the costs of production, or diverting capital from other investments and businesses. The response of individual firms regarding innovation will be based on many complex factors, both internal and external to that firm. Especially for large complex facilities, incremental innovations may offer a relatively low risk route to profitability (85,89,164). In smaller firms, diffusion may be a better strategy.

Innovation in the EG&S industry

This industry is comprised of firms whose primary business is the supply of environmental equip-

[23] Some critics note that these estimates often fail to incorporate that environmental policy 1) may stimulate economic growth by creating new markets in some sectors, and 2) may prevent decreasing productivity in sectors dependent on a healthy environment, such as agriculture or fisheries.

ment and services that control, treat, clean up, and/or prevent pollution and waste (197). Government regulation has created and sustained most of the markets for the EG&S industry and thus any changes in the way regulations are written may affect the health of the industry.

Diffusion of known technologies

Technology diffusion is the common follow-onto successful innovations. Diffusion occurs because firms find technologies beneficial and often essential if they are to be competitive. Subsequent producers or users of an innovation may modify the technology or the context into which it will fit, in order to gain advantage. Such adaptations are an important part of the process of technological change, and they commonly provide known solutions or best practices to firms that do not have the resources for in-house innovation. Some instruments that promote technology diffusion, however, may delay or impede a firm's search for innovations. A company could, of course, always choose to innovate for performance or cost reasons related to productivity.

Diffusion may bean ideal strategy when technological solutions for environmental problems are available but are not widely known or have not been widely adopted. This is especially so for small-to medium-sized firms that find the costs of information searching and R&D prohibitive. For these companies, diffusion may provide a way to reduce costs and achieve state-of-the-art abatement.

Summary of Instrument Performance

- **Effective:** ***Product bans, pollution charges***

O **It depends:** ***Tradeable emissions, challenge regulations***

V **Use with caution: —**

As indicated above, the empirical basis for understanding the relationships between policy instruments and technology innovation in sources and the EG&S industry is not well developed (197). Activities related to the diffusion of known technologies have been more widely discussed, but seldom with a focus on the impacts of specific policy instruments on these activities.

Innovation is essentially done in firms or within the networks to which the firm or its personnel are connected. And, even if a firm wants to innovate, it can not always accomplish its goal. Thus, the role of government in spurring innovation is necessarily limited to a set of important but ultimately insufficient activities (89). Nonetheless, it is possible to draw some tentative conclusions about differences among the 12 instruments in promoting technology innovation or diffusion.

As shown in table 4-8, the most effective instruments for promoting innovation are **product bans** and **pollution charges.** By removing a product or limiting its use in commerce, the agency creates a market for some other product or process. The consumer could be an end-user or a manufacturing facility that is using the product as part of an intermediary process in which value is being added along the way. **Pollution charges,** although not widely used in the United States, have the potential to keep steady pressure on firms to innovate to reduce the fees they must pay for residual discharges.

Tradeable emissions and **challenge regulations** increase the flexibility firms have to solve pollution problems and thus may be more likely to spur innovation. Depending on how they are used, however, these instruments also run the risk of being simply average or comparable to the performance of the other instruments.

The remaining instruments do not provide the same encouragement to innovate as those mentioned above, although none of them are necessarily barriers. In our overall strategy we weight innovation somewhat more heavily than diffusion. Thus, an instrument like a design standard, which can promote diffusion of technologies and provide incentives for the EG&S industry to innovate but which may reduce incentives for a regulated industry to innovate, might be approached cautiously.

Instruments that specify examples of technologies that would constitute compliance or make adoption of experimental technologies very risky

TABLE 4-8: Technology Innovation and Diffusion

	Fixed Target: Single-source				Fixed Target: Multisource			No Fixed Target				
	Product bans	Technology specifications	Design standards	Harm-based standards	Integrated permitting	Tradeable emissions	Challenge regulations	Pollution charges	Liability	Information reporting	Subsidies	Technical assistance
Technology innovation and diffusion	●	•	•	•	•	O	O	●	•	•	•	•
Innovation in regulated industry	●	V	V	•	•	O	O	●	•	•	•	•
Innovation in EG&S industry	•	V	●	•	•	O	O	●	•	•	•	V
Diffusion of technologies	•	●	0.		•	•	•	●	•	•	●	●

● = Effective O = It depends V = Use with caution • = Average

NOTE: These ratings are OTA's judgments, based on theoretical literature and reports of instrument use. The evaluation of each instrument on a particular criterion is relative to all other instruments. Thus, by definition most instruments are "average."" Effective" means that the instrument is typically a reliable choice for achieving the criterion "It depends" means that it may be effective or about average, depending on the particular situation, but it is not likely to be a poor choice And "use with caution" means that the instrument should be used carefully if the criterion is of particular concern.

SOURCE: Office of Technology Assessment, 1995

may make innovation a less attractive option for some firms. However, many of the instruments that are rated not quite as high for innovative technologies tend to promote diffusion of known technologies, which can also increase productivity and help meet environmental goals. Moreover, firms could still choose to innovate or to adopt known technologies for cost or performance improvements under a regime using almost any of these policy instruments.

Instrument-by-Instrument Comparison

● Product bans

Product bans are the instrument with the best chance of promoting technology innovation simply because they prohibit "business as usual." They represent at the time they are implemented a very stringent and certain action. However, because the industry response is left open, some type of innovation may occur, ranging from simple substitutions for an existing product or component to new products or processes. In markets where no substitutes are readily available, the product ban has the most potential to induce radical innovation.

In the case of consumer or industrial products such as polychlorinated biphenyls, phosphate detergents, asbestos, CFCs, etc., the affected industries have responded with environmentally superior products. However, this form of "radical technology forcing," requires a leap of faith on the part of the regulatory agency and reviewing institutions (118). Substitutes may not become available by the deadline or their costs may be much higher than anticipated.

For important products for which there are no substitutes, the approach invites a degree of brinkmanship that is sometimes difficult to manage in a regulatory setting. For example, when EPA initiated cancellation proceedings against the pesticide Mirex, its manufacturer protested that farmers and ranchers throughout the southeastern United States would be left defenseless against imported fire ants, because the only registered substitute for Mirex was a pesticide that was also the subject of an EPA notice of intent to cancel. In phasing out Mirex use over an 18-month period, EPA took the risk that other companies would come forward with alternative fire ant killers to fill the void left by the absence of Mirex; four substitutes did in fact become available before the end of the phaseout period (117).

● Pollution charges

The reason that economic studies rank **pollution charges** high on their ability to spur innovation is clear: firms pay more to achieve the same level of control than under direct controls, hence they can save more by innovating. Firms pay more under charges because they must still pay for pollution discharges, even after desired control levels have been reached, in addition to their control costs. By making pollution itself one of several production costs, pollution charges build in an incentive to innovate (59).

Pollution charges allow firms substantial flexibility to decide how to respond to signals about the costs of pollution. This flexibility includes an option to buy out of the system—that is, to pay to discharge if the firm wishes to do so.

In addition, while it is tempting to say that firms will innovate if EPA simply sets the charge high enough, setting the charge at the right level to get innovation rather than diffusion or continuing discharges is far from simple. In the past, pollution charges have not been widely used because of the political difficulties of establishing a fee high enough to achieve the desired level of pollution control. Charges have been widely used to fund pollution control agencies, but have not been set high enough to change behavior (193).

○ Tradeable emissions

In theory, **tradeable emissions** should promote innovation. The primary advantage of a tradeable emissions program is that it allows firms with widely varying marginal costs of abatement control to cooperate in meeting environmental standards with lower overall costs. Since they are used infrequently, not much is known about how firms will respond in terms of innovation. Yet, firms with high marginal costs could be expected to innovate to reduce pollution instead of buying emission credits. However, firms facing relatively high control costs can also buy credits instead, thus reducing the pressure for innovation (111). The degree of innovation will strongly depend on the stringency of the emissions cap faced by the facilities (197).

Although tradeable emissions might initially promote adoption of technologies among firms for which the technology achieves the standard, the degree of stringency in later emission reductions for the program might actually impede *diffusion* of new technologies. For example, under an increasingly competitive trading process, a firm that developed effective and relatively cheap technologies for pollution abatement might try to protect its position through secrecy or patenting because diffusion would reduce the value of the firm's credits. However, it could also choose to recoup the costs of innovation by selling the innovation at a very high price (121).

The effect of a tradeable emissions regime on the EG&S industry will depend on the structure of the particular regulated industry. If the industry relies heavily on suppliers for compliance technologies or services, it may have indirect incentives for innovation or increased opportunities for diffusion of known solutions to more clients. For example, in the automobile or electric power industries, such a regime might create pressure on the suppliers for innovations; in the chemicals industry, the EG&S industry would be less affected.

Tradeable emissions, in comparison to uniform standards that would apply under a design standard, clearly widens the field of available technologies. For example, analysts expect to see a wider array of control approaches under the acid rain tradeable emissions program than if a uniform standard had been adopted. This also applies to other multisource instruments such as integrated permitting or challenge regulations. Again, this may be more likely to encourage diffusion than innovation, especially if the EG&S industry plays a major role.

Challenge regulations

The setting of long-range goals and scheduled targets allows industry to see where an agency is going with its policy and in that way provides some level of certainty or stability that can help firms decide about the risks involved in innovating. A major difficulty for the United States is the degree and frequency to which political pressures can affect the stability of such national environmental policy setting.

Like most of the other instruments, **challenge regulations** do not ensure that innovation will occur. Instead, the strategy incorporates and implements the idea that the knowledge and expertise required to solve problems in an innovative way generally resides in the companies and not in the regulatory agency. A possible advantage for spurring innovation is the degree to which challenge regulations can encourage an industry or set of firms to find that balance between cooperation and competition that results in low-cost, innovative solutions for meeting the targets.

The frequent duplication of environmentally oriented R&D among companies in some industries was mentioned by technical experts in a 1991 survey as a key opportunity for cost savings while still promoting innovation (74). Other countries, such as Germany, the Netherlands, and Japan, that have encouraged such cooperation in R&D and information sharing on innovative environmental technologies have a positive track record. In the United States, a range of nonenvironmentally related policies such as antitrust regulations and the lack of strong organizations or institutions such as trade associations constrain opportunities for such collaboration.

Harm-based standards

Companies report a preference for harm-based standards over design standards because of the flexibility they provide in choosing a compliance strategy for the source (105). A standard expressed, for example, as an allowable emissions rate or pollutant concentration in effluents, but without a restriction on how to meet it, gives firms the freedom to develop the best solution for that source.

If the standard is set to achieve a desired level of environmental quality, then sources may face nonuniform requirements. For those facing a more stringent control requirement, innovation may be the best way to achieve compliance. However, it is also possible that existing technology is available for meeting the standard, either from an EG&S firm or from another firm. Competition among EG&S firms for clients might also result in innovations to reduce the costs of meeting harm-based standards.

If the difference between the acceptable risk goal which must be attained and the current capability of technologies to meet that goal is substantial, firms have an incentive to innovate. However, once that goal has been met, productivity concerns rather than meeting the goal become the key source of continuing pressure on a firm to innovate, although some firms may decide to improve environmental performance for other reasons.

Examples of **harm-based standards** that have been studied for their impact on technology innovation include SO_2 standards for copper smelters (108) and mercury in the chloralkali industry, vinyl chloride, asbestos, cotton dust, and lead (14). These studies concluded that major innovations tended to come from newer firms or from firms more heavily affected by the regulations. Diffusion of innovations were faster when the new technologies were developed by the EG&S industry.

For small firms, combining harm-based standards with other instruments such as technical assistance can promote diffusion of known technologies that can meet the standard or that would be considered best controlling technologies at the time.

Design standards

One of the original goals for **design standards** was to spur continual innovation by revising regulations as the state of the art of technologies improved (13). Moreover, some argue that the legislative language developed for design standards (e.g., BAT, MACT, LAER, BACT, etc.) was intended to provide incentives for firms to continue innovating incrementally over a period of time until the unwritten goal—or, in the case of the CWA, the written goal—of zero or near zero emissions was achieved.

In practice, however, this desired link between design standards and continuous innovation has seldom happened. For example, under CWA standards that considered technology forcing five and 10 years out from the statute, industry was able to meet nearly all of the five-year standards and most of the 10-year standards with existing technologies (117). Agencies may also be reluctant to reopen rulemakings on design standards once they are in place for many reasons, including some of the political and analytical difficulties outlined in the sections on *assurance* and *adaptability* to change (30).

The common use of a "reference" technology for design standards probably hurts efforts to spur innovation. Since no source is required to achieve pollution control beyond what the regulatory agency knows can be done with existing technologies, innovation would not be necessary to satisfy the standard.

However, if the reference technology would be very expensive for a source to adopt, there might be an incentive for innovation. While the "or equivalent" provision accompanying design standards allows a firm or the EG&S industry to substitute an innovative technology, most firms report that the effort to establish equivalency is often difficult or risky. This is especially true when the model technology is written into the permit so that preapproval of a change is required rather than a demonstration of equivalent performance after installation. Moreover, the conventional wisdom has been that, contrary to original expectations, firms have not been inclined to seek innovations because of concern that new facilities would be forced to adopt them or that old facilities would have to adopt them when their permits are renewed (13,105).

The designation of uniform technology requirements for source compliance has been very important for establishing and maintaining markets for the EG&S industry, since any reconsideration of the technologies listed or not listed may create uncertainty for suppliers in that industry as well (153). Particularly when available technologies were not widely used prior to issuance of the standard, EG&S firms can play a large and effective role in promoting diffusion of the technologies.

Technology specifications

Technology standards, rarely used, are based on known technologies and thus could promote wide diffusion of technologies or restrictions of others. This type of uniform standard can create a relatively stable set of market conditions for the EG&S industry.

Once the technology is specified, however, and adopted by sources, the pressure for technical improvements in environmental performance is reduced. Unless the standards are revised to track technological developments, pressure to innovate will come from productivity concerns or from the desire to escape the regulatory net altogether (13,105).

Integrated permitting

Integrated permitting, almost by definition, allows the regulation of facilities in new ways. The task of considering the facility as a whole gives both the regulatory agency and the firm the opportunity to develop new techniques or processes for meeting environmental goals. It does not necessarily lead to innovation, but the firm is free to find innovative solutions. For example, the integrated permit for VOCs issued to the 3M facility in St. Paul, Minnesota, gave the firm complete flexibility to identify reductions that could be made more cost effectively than others and to trade off those sources. The price 3M paid for this flexible permit was significantly lowered allowable emissions and the investment and implementation of an innovative continuous emissions monitoring system for VOCs (149).

Looking across media may provoke some innovation in technical processes. The innovation literature suggests that firms faced with having to rethink how they do business are currently using such opportunities to go back to the drawing board and redesign entire processes to capture efficiencies—that is, it is often cheaper to solve 10 problems at once than separately, one at a time. This conclusion suggests that integrated permits may offer a good opportunity for spurring innovation (150).

However, as long as integrated permitting is tied to the facility level and to the permit process, the firm is limited to choosing what is best for it in a particular facility setting. The impact of this type of permitting on diffusion for EG&S firms is uncertain, depending on the particular relationship of a facility to suppliers and to the particular problems being solved.

Liability

The uncertainty **liability** creates about outcomes can encourage firms to innovate to reduce or control pollution rather than take a chance on disposal or control of wastes. However, if signals about accountability are too inconsistent, liability might become counterproductive. Except for CERCLA provisions, that have been widely criticized, there is very little systematic evidence about how firms behave in the face of statutory provisions (as opposed to the body of common law known as torts or the issues of enforcement of civil and criminal penalties).

Theoretically, the possibility of suffering large judgments for compensatory damages if found in violation of environmental standards is regarded as an incentive for every firm to comply. Neither governmental entities nor companies, however, strictly comply with all environmental regulations, usually because the laws require more than a regulated entity knows how to do (100). Moreover, firms may vary regarding how risk-averse they are.

Liability can create both direct and indirect pressures on firms to innovate. The direct responsibility for remediation of environmental damage can promote problem solving by firms to reduce hazards. At a minimum, most firms want to avoid the negative publicity that can accompany the types of environmental degradation that result in efforts to secure compensatory damages.

The more indirect pressures are increasingly being seen in requirements by lenders and insurance companies who want assurances that firms are behaving in an environmentally responsible way or that property they are buying or insuring is free from liability under environmental laws. Liability provisions, especially associated with remediation efforts under CERCLA, have created a significant market for the EG&S industry. Banks and insurers themselves are now developing more in-house capability to evaluate environmental performance and to diffuse technical information to clients about how to prevent or solve environmental problems.

Information reporting

For technology innovation, the major impact of **information reporting** is likely to come from the way the sources interpret and act on the information they gather. Several firms have said that they were surprised by the results of the information they compiled for programs such as TRI and used the information to make changes in their facilities to reduce emissions (105). To the extent that information reporting, such as TRI or self-audits, can improve a firm's knowledge of its facility's emissions, that knowledge may be linked by the firm to other productivity concerns to produce innovations (159). However, the response does not have to be innovative; an incentive to lower emissions is by no means equivalent to an incentive to innovate.

Subsidies

Subsidies are widely used in many countries to promote technology development, although support for environmental technologies has been used only recently in the United States (133). There are two major approaches to subsidizing technology innovation and diffusion. In the first, the government offers to pay firms well enough to spur reduced discharges through innovation. For example, subsidies could be used to promote diffusion of best practices to reduce nonpoint source pollution by subsidizing landowners, particularly farmers, who cooperate with guidelines.

The other major approach is to subsidize front-end research and development activities such as generic R&D, consortia arrangements, or specific products. For example, the CWA used to contain an Innovative and Alternative Technologies Program intended to promote innovation and diffusion of new sewage treatment technologies. The United States has used this approach most frequently in the agricultural, aircraft and aerospace, defense, and pharmaceutical industries, with a pattern of widespread subsidies rather than narrowly targeted project subsidies.

While experience indicates that these kinds of subsidies are indeed successful in promoting technology innovations (85), the record has been mixed, with some projects judged as failing to deliver desirable results (33). With either approach there is likely to be disagreement about whether it produces innovations that would not otherwise have occurred and, consequently, whether the redistribution of public monies into private hands is desirable or effective.

Technical assistance

Technical assistance is an effective instrument for promoting technology diffusion. These programs are not regarded as particularly effective in promoting innovation, particularly in large sources where considerable in-house expertise is available.

The typical clients targeted by technical assistance programs are companies or governmental entities that have lagged behind the state of the art. These programs have been widely favored for diffusing known techniques and methods, especially among smaller and medium-sized firms.

The federal government has considerable experience in using technical assistance to improve performance in an industry. For example, technical assistance programs were the backbone of the federal agricultural extension service's efforts to diffuse best practices and the evidence seems conclusive that it has been an extremely effective policy instrument in that setting. More recently, the federal government has been using the concept of technical assistance to promote cooperation among companies with similar technical environmental problems. For example, the Industry Cooperative for Ozone Layer Protection has developed standardized approaches to CFC substitution that are being disseminated to companies in other countries.

Government-sponsored technical assistance programs to support diffusion may either complement or actually compete with efforts within the EG&S industry. For example, some federal efforts at technical assistance are contracted out to the EG&S industry, using those firms as agents for diffusion.

SUMMARY

This chapter presented a criterion-by-criterion comparison of the effectiveness of the 12 policy instruments or tools. Our composite picture of instrument performance on all seven of the criteria and their underlying components, shown in table 4-9, underscores that trying to satisfy several, much less all, of these when addressing a particular environmental problem may be quite frustrating.

Yet policymakers are typically faced with these difficult tradeoffs among broad concerns such as lowering the *costs and burdens* for industry and government, achieving the desired *environmental results*, and spurring the development and use of new *technologies*. Choosing the most effective

TABLE 4-9: Strengths and Weaknesses of Policy Instruments

● = Effective
○ = It Depends
▽ = Use with caution
• = Average

		Fixed Target: Single-source				Fixed Target: Multisource			No Fixed Target				
		Product bans	Technology specifications	Design standards	Harm-based standards	Integrated permitting	Tradeable emissions	Challenge regulations	Pollution charges	Liability	Information reporting	Subsidies	Technical assistance
Environmental results	**Assurance of meeting goals**	●	●	●	●	●	○	•	•	•	▽	▽	▽
	Action forcing	●	●	●	●	●	●	○	•	•	▽	▽	▽
	Monitoring capability	●	●	○	•	○	▽	▽	▽	▽	•	•	•
	Familiarity with use	•	▽	●	●	•	•	▽	▽	•	●	●	●
	Pollution prevention	●	○	○	•	•	•	•	•	○	•	•	●
	Gives prevention an advantage	●	○	○	•	○	•	•	•	○	•	○	○
	Focuses on learning	•	▽	▽	▽	•	•	○	•	○	○	•	●
	Environmental equity and justice	•	•	•	•	•	▽	▽	▽	•	●	●	●
	Distributional outcomes	•	•	•	●	•	▽	▽	▽	•	•	•	•
	Effective participation	•	•	•	•	•	▽	▽	▽	•	●	●	●
	Remediation	•	•	•	•	•	•	•	•	●	•	●	●
Costs and burdens	**Cost-effectiveness and fairness**	▽	▽	•	•	○	●	○	•	•	○	•	○
	Cost-effectiveness for society	▽	▽	•	•	•	●	○	●	•	○	▽	•
	Cost-effectiveness for sources	▽	▽	•	•	○	●	○	•	•	○	●	●
	Fairness to sources	▽	▽	•	•	•	●	●	▽	▽	•	•	•
	Administrative burden to sources	•	•	•	•	▽	▽	▽	•	▽	•	•	•
	Demands on government	•	•	•	▽	•	•	○	•	•	●	▽	•
	Costs	•	•	•	▽	•	•	○	•	•	●	▽	•
	Ease of analysis	▽	•	•	▽	▽	○	○	▽	•	•	•	•
Change	**Adaptability**	▽	▽	▽	•	•	•	○	•	●	●	•	●
	Ease of program modification	▽	▽	▽	▽	▽	▽	•	▽	●	●	○	●
	Ease of change for sources	▽	▽	▽	•	○	●	●	●	●	●	•	●
	Technology innovation and diffusion	●	•	•	•	•	○	○	●	•	•	•	•
	Innovation in regulated industries	●	▽	▽	•	•	○	○	●	•	•	•	•
	Innovation in EG&S industry	•	▽	●	•	•	○	○	●	•	•	•	▽
	Diffusion of technologies	•	●	●	•	•	•	•	●	•	•	●	●

NOTE: These ratings are OTA's judgments, based on theoretical literature and reports of instrument use. The evaluation of each instrument on a particular criterion is relative to all other instruments. Thus, by definition most instruments are "average." "Effective" means that the instrument is typically a reliable choice for achieving the criterion. "It depends" means that it may be effective or about average, depending on the particular situation, but it is not likely to be a poor choice. And "use with caution" means that the instrument should be used carefully if the criterion is of particular concern.

SOURCE: Office of Technology Assessment, 1995.

policy instruments to achieve a goal can thus become a very complicated task for policymakers whether at the state, local, or federal level.

Clearly, choosing an instrument for its strength on any one criterion may diminish the chances of achieving any of the other criteria on which it performs poorly. The single-source tools that can be so effective at providing assurance of meeting goals, for example, are much less effective at addressing concerns about cost-effectiveness and fairness or adaptability to change. However, multisource tools that facilitate lower costs and burdens for industry and may spur technology innovation can be more difficult to monitor and raise concerns about the distribution of costs and benefits among various communities.

Chapter 1 of this report discusses one approach for narrowing the choice of instruments by posing a set of questions about both the problem itself and the preferences of the policymakers. After working through these questions, policymakers may find the perfect instruments for dealing with the problem. However, they are just as likely to be faced with the kinds of tradeoffs discussed in this chapter. Rather than depend on a single instrument, policymakers may want to combine two or more instruments to shore up the weaknesses of one with the strengths of the others.

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