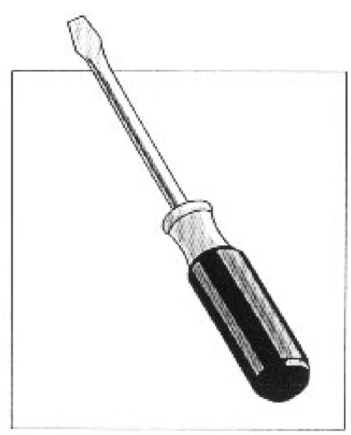
Executive Summary

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

Single-Source Tools

Harm-Based Standards	Describe required end results, leaving regulated entities free to choose compliance methods.
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.
Technology Specifications	Specify the technology or technique a source must use to control its pollution.
Product Bans and Limitations	Ban or restrict manufacture, distribution, use or disposal of products that present unreasonable risks.

Multisource Tools

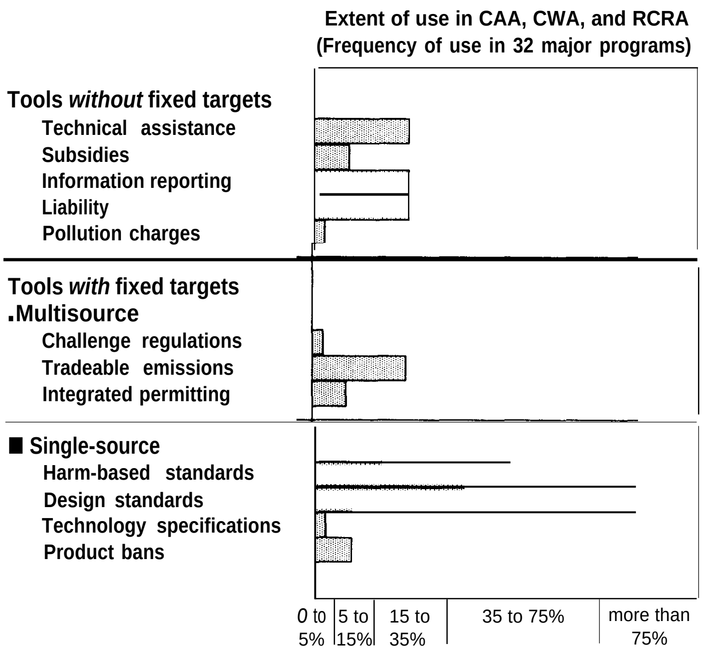
Integrated Permitting	Incorporates multiple requirements into a single permit, rather than having a permit for each individual emissions source at a facility.
Trackable Emissions	Allow regulated entities to trade emission control responsibilities among themselves, provided the aggregate regulatory cap on emissions is met.
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.

Tools That Do Not Directly Limit Pollution

Pollution Charges	Require regulated entity to pay fixed dollar amount for each unit of pollution emitted or disposed; no ceiling on emissions.
Liability	Requires entities causing pollution that adversely affects others to compensate those harmed to the extent of the damage.
Information Reporting	Requires entities to report publicly emissions or product information.
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.

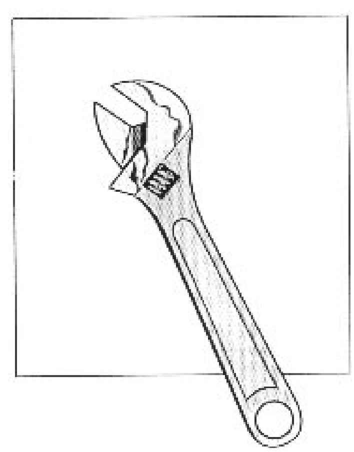
The search for "smarter" ways to pursue environmental protection policies has typically focused on one or more of the following three issues:

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.

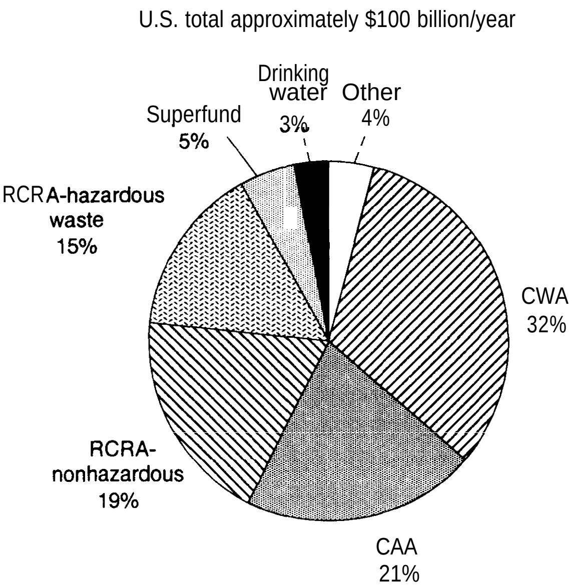
OECD countries also make heavy use of subsidies, including grants, subsidized-interest loans, income tax allowances, and deposit-refund programs. Subsidies are offered to promote research on pollution control technologies, lowering the effective cost of certain control options and compensating firms 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 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	•	●	[illegible]	•	•
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 rule-making—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 multisource 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
∇ = 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
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.