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Robert N. Stavins and Bradley W. Whitehead

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EXECUTIVE SUMMARY

The environmental movement is poised to enter a second generation. For two decades it prompted significant improvements in the quality of our air, water, land, and natural resources, primarily through "command and control" regulations that essentially told firms what pollution control technology to use and how much pollution they could emit. Now, in an era of new environmental challenges and heightened sensitivity to regulatory compliance burdens, there is an emerging awareness that market forces can offer a more powerful, far-reaching, efficient, and democratic tool than centralized regulations for protecting the environment.

This paper argues that the progressive challenge for environmentalists in the 1990s is to move toward greater reliance on market-based policies. In particular, our nation can combat many old and new environmental threats with one subset of market-based approaches, called pollution charges or "green charges."

Command and control regulations were powerful in the early battles against environmental degradation, but they have begun to reveal many of the same limitations that led to the collapse of command and control economies around the globe. Command and control regulations are often economically inefficient -- that is, excessively costly -- because they ignore market signals about which firms can reduce emissions most cheaply. Command and control rules can hamper technological innovation by locking firms into outdated pollution control equipment. They ignore important differences among individuals, firms, and regions. And command and control regulations tend to make the environmental debate a closed, technical discussion among bureaucrats and vested interest groups rather than an accessible public dialogue.

Market-based policies start with the assumption that the best way to protect the environment is to make it in the daily self-interest of individuals and firms to do so. The key to greater environmental protection, then, is not more centralized rulemaking, but decentralization -- by changing the financial incentives that face millions of firms and individuals in their private decisions about what to consume, how to produce, and where to dispose of their wastes. As a result, market-based policies offer many important advantages:

- They can enable environmental protection to be pursued at less cost of compliance to private industry, and thereby at less cost to consumers.

- They can give firms a constant incentive to find new and better technologies for combating pollution rather than locking one kind of pollution control technology into place.

- They can help move environmental protection laws and regulations out of the exclusive domain of experts -- scientists, economists, lawyers, and lobbyists -- and open up the process to the public.

- They help decentralize power from public bureaucrats to private firms and individuals by building incentives for pollution control into the cost structure, and, as a result, into daily decisions and long-term strategies.

- They make the incremental costs of environmental protection more visible, and thus focus public debate on the tradeoffs between protection and other economic goals, rather than simply on the evils of pollution.

- Because some market-based approaches such as pollution charges raise substantial revenues, they can enable government to reduce "distortionary" taxes -- ones that reduce market efficiency by taxing desirable activities, such as investment and labor - - and replace them with levies that discourage socially undesirable behavior, such as pollution and degradation of natural resources.

While such market-based approaches are not a new idea -- they have been proposed by economists for the past 25 years -- their use has been widely resisted: by environmentalists who view the market as the problem rather than a solution; by environmental bureaucrats who resist change from an old regulatory system that emphasized highly-technical specifications about pollution control devices and standards; by lobbyists on both sides of the debate whose role in the process could be endangered by this new approach to environmental protection; by elected officials who are either worried that the public will view these market-based approaches as new taxes, or simply resistant to new ideas; and, of course, by those who oppose environmental protection altogether.

But now a confluence of forces has heightened interest in market-based approaches. Sluggish economic growth, high public sector deficits, and concerns over international competitiveness have focused new concern on the private and public costs of environmental regulation; some estimate that we now spend over $100 billion annually to comply with Federal environmental rules. Changes of attitude within the environmental movement and bureaucracy also seem to herald a new openness to using market forces to regulate the market itself. And the emergence of new threats to the environment, such as global warming, has combined with the stubbornness of old threats, such as toxic wastes, to spur the search for better ways to control pollution. These forces are likely to focus attention on market-based environmental policies, if not as a replacement for current regulatory approaches, then at least as a valuable new set of tools for pursuing environmental quality.

The most significant step to date at the Federal level was the inclusion of tradeable "pollution-reduction credits" in last year's Clean Air Act Amendments. These permits represent a distinctly market-based approach to combating acid rain by encouraging the greatest reductions in smokestack emissions from those electric utilities that can make those reductions most efficiently. While some of the possible savings from trading may

ultimately be eroded by regulatory constraints, the potential for cost savings is enormous, and this action may have launched a new era in environmental policy. Legislators and other policy makers are now discussing the potential for tradeable permits for a broad range of environmental problems, ranging from the recycling of newsprint to the control of greenhouse-gas emissions.

Tradeable permits, however, are by no means the only market-based instrument at the disposal of policy makers. In fact, a portfolio of market incentives exists, and this paper examines one of the more promising of these -- green charges. The paper begins with a discussion of market-based approaches in general -- why and when they make sense, why their use has been resisted historically, and what forces are now overcoming that resistance.

The paper then discusses the particular case of green charges. It examines how green charges work: they force firms or individuals to pay for the external costs of pollution and to incorporate those added costs into their daily decision making; in the parlance of economists, they "internalize the externalities." The paper illustrates how green charges could be put into use in the context of four specific environmental challenges:

- Global Warming. Carbon charges to reduce "greenhouse" gases, as part of U.S. efforts to combat global warming.
- Motor Vehicle Fuel Efficiency. Gasoline taxes to foster greater fuel efficiency by affecting the kinds of automobiles people choose to buy and the amounts they choose to drive.
- Garbage and Landfills. More effective charges to households for trash pick-up, and new charges to retail consumers for certain kinds of containers, in order to encourage conservation and reduce the volume of solid waste going into municipal landfills.
- Toxic Wastes. "Deposit-refund" systems (akin to the idea behind deposits on returnable bottles) to help ensure the proper disposal of the 20 million lead batteries disposed each year, as well as industrial solvents and other hazardous wastes.

This paper argues that in these and other settings green charges can provide environmental solutions that are more cost effective, require less government intervention, encourage greater conservation, and spur the development of better technologies.

The argument for green charges is fundamentally political as well as technical. The American public has been shielded for years from many of the very real trade-offs involved in establishing our environmental goals and standards. Policy formulation has been shrouded in technical complexity, which obscures the more basic choice of how much we are willing to sacrifice for increased environmental quality. Conventional regulatory approaches impose costs on industry and consumers that are not readily visible. Because neither policy makers nor citizens can see how much they are paying for given levels of environmental protection, they have little basis for weighing relative risks.

Green charges bring these important tradeoffs into the open civic arena, where they belong, by making the incremental costs of environmental protection explicit. As a result, policy discussions can move away from a narrow focus on technical specifications to a broader consideration of goals and strategies. This shift should encourage the involvement of the American public in debates over the right degree of environmental protection. In this way, the public can recapture the critical decisions of environmental goal-setting from bureaucrats, technicians, and special interest groups.

Because green charges require political and bureaucratic change, they are unlikely to be adopted instantly or without controversy. But ultimately, rising concerns over economic stagnation, high deficits, and new environmental challenges are likely to make green charges increasingly attractive in the coming years. And the old hesitancy to adopt such market-based approaches may be overcome as politicians discover that they can be explained to voters in terms that resonate well with Americans' fundamental sense of fairness: "the polluter ought to pay."

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THE GREENING OF AMERICA'S TAXES: POLLUTION CHARGES AND ENVIRONMENTAL PROTECTION

Robert N. Stavins and Bradley W. Whitehead*

1. MARKET-BASED INCENTIVES FOR ENVIRONMENTAL PROTECTION

As the nation prepares to address old and new environmental challenges in the 1990s, it finds itself in a fundamentally changed economic and political context from the 1970s, when the first landmark environmental measures were enacted. More than a decade of high budget deficits, sluggish productivity growth, and intensified foreign competition has spurred interest in environmental approaches that lower compliance and administrative burdens for industry and government. Public restiveness over the size and cost of government has also heightened interest in approaches that require less bureaucracy and public sector intrusion into business and household decisions.

These forces for change have led to a quest for innovative environmental policy instruments. This paper examines pollution charges (or "green charges"), which are one such innovative approach, and investigates their usefulness for current environmental challenges. The paper explains the logic behind market-based approaches in general, analyzes the political dynamics that have resisted the use of such approaches, and then focuses on pollution charges, which have gone virtually unused at the national level despite their tremendous promise for addressing many of the nation's current environmental challenges. The paper examines variants within the category of pollution charges, and suggests several ways in which they could be used to meet such environmental goals as reducing "greenhouse" emissions, increasing motor vehicle fuel efficiency, improving solid waste disposal, and cleaning up toxic wastes.

1.1 New Challenges for Environmental Policy

Many of the environmental efforts of the 1970s and early 1980s viewed "the market" as the villain in the "pollution tragedy": because the market drives firms to pursue profits with single minded disregard for the environmental consequences of their activities, the market must be checked. Under this view, government would make decisions concerning appropriate technologies and emissions taking into account "externalities" -- social costs created by the firms' actions but borne by others in society -- which the firms, on their own, would ignore.

Under this approach, the government's role was not merely to specify policy goals, but also to intervene in decisions about the production process itself. The explicit goal of some legislation during this period was to maximize the benefits of environmental protection without regard to the costs involved. Indeed, some statutes and regulations explicitly forbid consideration of costs in setting standards.[1]

This philosophy has produced much environmental progress over the last two decades. In many spheres, the environment is cleaner now than it was before. But the United States and the world continue to face major environmental challenges, including ongoing problems -- such as urban smog, groundwater pollution, and acid rain -- and newly recognized problems -- such as global climate change and indoor air pollution. Moreover, the economic and political context in which environmental policy is formulated has changed significantly. The challenge for policy makers today is to devise policies that do "more with less," and harness rather than obstruct market forces.

Doing More With Less: The Need for Cost Effectiveness

The days when the U.S. could afford to consider environmental protection in isolation from costs have ended. The U.S. Environmental Protection Agency (EPA) estimates that we now spend over $100 billion annually to comply with Federal environmental laws and regulations;[2] there is heightened concern over the impact of these regulations on the strength of our national economy and our ability to compete in international markets.[3] As a result, policy makers are exercising increased caution about the degree and type of regulatory burdens placed upon businesses and individuals.

Federal, state, and local budget deficits make it - less likely that we can increase environmental protection simply by spending more money on programs and policies already in place.[4] There is new sensitivity to private costs as well; the failures in 1990 of the "Big Green" referendum in California and a major environmental bond issue in New York State are just two examples of environmental initiatives that were defeated because compliance costs were perceived as too high. Citizens and policy makers have not lost sight of the benefits of environmental protection, but they are giving increased attention to cost effective environmental policies. To some, this means getting more environmental protection for the same level of expenditures. To others, it means getting the same level of protection for less cost. To both, it means making the most of scarce resources and maximizing returns on the resources we invest -- business costs, regulatory effort, political capital, taxes -- to improve the quality of our environment.

Harnessing, Not Obstructing, Market Forces

An indicator of these new concerns was the adoption of a market-based approach, tradeable "pollution reduction credits," in last year's Clean Air Act Amendments. The adoption of this innovative approach suggests that political leaders are coming to recognize that market forces are not only part of the problem, but also a potential part of the solution. By dictating behavior and removing profit opportunities, much environmental regulation has placed unnecessary cost burdens on the economy and has stifled the development of new, more effective environmental technologies. Furthermore, such policies have helped engender an adversarial relationship among regulators, environmentalists, and private industry; as a result, excessive resources have often been directed to litigation and other forms of conflict among affected parties.

Policies are needed to mobilize and harness the power of market forces on behalf of the environment, making economic and environmental interests compatible and mutually supportive.[5] Policy makers must begin to link the twin forces of government and industry without extravagant investment. This task will require both open minds and rigorous examination of all options.

1.2 Policy Mechanisms for Environmental Protection

There are two steps in formulating environmental policy: the choice of the overall goal, and the selection of a means or "instrument" to achieve that goal.[6] Although both the goal and the mechanisms for achieving the goal have important political ramifications, this paper focuses on the latter.[7] Market-based environmental policies, which focus on the means of achieving policy goals, are largely neutral with respect to the selected goals; instead, they provide cost-effective methods for reaching those goals. Before investigating market incentives, in general, and pollution charges, in particular, it is useful to review the regulatory approach most frequently used -- command-and-control.

Conventional Command-and- Control Regulatory Approaches

Command-and-control regulations tend to force all firms to behave the same when it comes to pollution, shouldering identical shares of the pollution-control burden regardless of their relative costs. Government regulations typically set uniform standards for all firms; the most prevalent standards are technology- and performance-based standards. As the name suggests, technology-based standards specify the method, and sometimes the equipment, that firms must use to comply with a regulation.[8] In one case, all firms in an industry might be required to use the "best available technology" to control water pollution; in a more extreme example, electric utilities may be required to utilize a specific technology, such as electrostatic precipitators, to remove particulates. Performance standards, on the other hand, set a uniform control target for each firm while allowing them some latitude in how they meet it. Such a standard might set the maximum allowable units of pollutant per time period, but be neutral with respect to the means by which each firm reaches this goal.

Holding all firms to the same target can be both expensive and counterproductive. Although uniform standards can sometimes be effective in limiting emissions of pollutants, these standards typically do so at relatively high costs to society. Specifically, such standards can force some firms to use unduly expensive means of controlling pollution.[9] The reasons are simple: the costs of controlling emissions can vary greatly between and even within firms, and the right technology in one situation may be wrong in another. Indeed, the cost of controlling a given pollutant may vary by a factor of 100 or more among sources, depending upon the age and location of plants and the available technologies. [10]

This regulatory approach also tends to freeze the development of technologies that could provide greater levels of control. Little or no financial incentive exists for firms to exceed their control targets, and both types of standards contain a bias against experimentation with new technologies: a firm's "reward" for trying a new technology may be that it will subsequently be held to a higher standard of performance, without significant opportunity to benefit financially from its investment. As a result, dollars that could be invested in technology development are diverted to legal battles over what are or are not acceptable technologies and standards of performance.

Market-Based Policies

Whereas command-and-control policies seek to regulate the individual polluter, market-based policies train their sights on our real target of concern: the overall amount of pollution for a given area. What we care about, after all, is not how many particulates the local widget factory emits, but the quality of the air we breathe while walking downtown or sitting in our back yard. Thus, under a market-based approach, government establishes financial incentives so that the costs imposed on firms drive an entire industry or region to reduce its aggregate level of pollution to a desired level; then, as in any regulatory system, the government monitors and enforces compliance.

In policy terms, market-based policies achieve the same aggregate level of control as might be set under a command-and-control approach, but they permit the burden of pollution control to be shared more efficiently among firms. In economic terms, market-based policies equalize the level of marginal costs of control among firms, rather than the level of control.[11] That is, they provide a market incentive for the greatest reductions in pollution by the firms who can do so most cheaply. The result is a cost-effective outcome in which fewer total economic resources are used to achieve the same level of pollution control (or more pollution control is obtained for the same level of resources).

Theoretically, the government could achieve such a cost-effective solution by setting different standards for each individual firm, equating their marginal costs of control. To do this, however, the government would need detailed information about the costs each firm faces -information that the government clearly lacks and could obtain only at great cost, if at all. Market-based policies provide a way out of this impasse, for they lead "automatically" to the cost-effective allocation of the pollution-control burden among firms. By forcing firms to factor environmental costs into their decision making, these systems create powerful incentives for firms to find cleaner production technologies.
Market-based incentives also make the environmental debate more understandable to the general public by focusing attention on questions about what our environmental goals should be, rather than on difficult technical problems about competing means for reaching those goals.[12] As we discuss later, one of the reasons market-based systems are not more widely used is because many technical experts, out of habit or vested interest, have sought to keep the complexity in -- and the public out -- of such debates.

Market-based incentive systems do not represent a laissez-faire, free-market approach. They recognize that market failures are typically at the core of pollution problems where the decision making processes of firms and consumers do not reflect the consequences of those decisions for society. At the same time, an incentive-based policy rejects the notion that such market failures justify "scrapping" the market and dictating the behavior of firms or consumers. Instead, they provide freedom of choice to businesses and consumers in determining the best way to reduce pollution. By ensuring that environmental costs are factored into each firm's (or individual's) decision making, incentive-based policies harness rather than impede market forces and channel them to achieve environmental goals at the lowest possible cost to society at large.

Market-based incentive systems, at the broadest level, fall into four categories:

- Pollution Charges. Under this approach, which is the primary focus of this paper, polluters are charged a fee on the amount of pollution they generate. In one category of pollution charges, "deposit-refund systems," all or part of some initial charge is rebated if the individual or firm takes certain actions.

- Tradeable Permit Systems. This was the approach used in the new Clean Air Act Amendments for acid-rain control. Under this mechanism, the government establishes an overall level of allowable air pollution and then allocates permits among the firms (chiefly electric utilities) in a relevant geographic area so that each firm is allowed to emit some fraction of the overall total. Firms which keep their emissions below the allotted level may sell or lease their surplus permits to other firms or use them to offset excess emissions in other parts of their own facilities.[13]

- Removal of Market Barriers. In some cases, substantial gains can be made in environmental protection by simply removing existing government-mandated barriers to market activity. For example, measures that facilitate the voluntary exchange of water rights can promote more efficient allocation and use of scarce water supplies, while curbing the need for expensive and environmentally disruptive new water-supply projects.[14]

- Eliminating Government Subsidies. Many existing subsidies promote economically inefficient and environmentally unsound development. The U.S. Forest Service's "below cost timber sales," which recover less than the cost of making timber available, are a major example.[15] These subsidies encourage excessive timber cutting, which leads to substantial loss of habitat and damage to watersheds.

Different mechanisms will be appropriate for different environmental problems. No single approach is a panacea for all problems. Neither market-based policies nor conventional, command-and-control regulations hold all the answers. Furthermore, when market-based approaches are appropriate, specific circumstances will dictate which of the above categories is best.

A discussion of the relative merits of permit policies and pollution charges is provided in the Appendix to this paper.

1.3 The Political Emergence of Market-Based Environmental Policies

The use of market forces to protect the environment is not a new idea. Economists have called for market-based environmental policies for the past twenty-five years.[16] It is only recently, however, that the broader policy community has begun to regard market instruments favorably. It should be recalled that President Lyndon Johnson's proposal for effluent fees and President Richard Nixon's recommendations for a tax on lead in gasoline and a sulfur dioxide emission fee were dismissed with little consideration.
It is important to understand what political forces have prevented broader acceptance of market-based environmental regulation over the years, for these same forces are likely to resist further use of such approaches beyond the new Clean Air Act Amendments. Four such forces have been most powerful.[17]

The first of these is the adversarial attitude that characterized the beginnings of the environmental movement. Throughout much of the 1960s and 1970s, that movement typically characterized pollution more as a moral failing of corporate leaders (and political leaders) than as a by-product of modern civilization that can be regulated and reduced but not eliminated. While that characterization may have been necessary and successful from a political standpoint, it resulted in widespread antagonism toward corporations and a suspicion that anything supported by business was probably bad for the environment. Thus, for many years, market-based incentives were characterized by environmentalists, not only as impractical, but also as "licenses to pollute."[18] Over time, environmental groups have frequently applied a different and more rigorous standard in measuring market-based systems against their command-and-control counterparts, possibly because of their belief that market-based systems legitimize pollution by purporting to sell the right to pollute.[19] This old suspicion likely continues among many rank-and-file environmentalists.

A second source of resistance to market-based approaches has been the self-interest of segments of the environmental bureaucracy whose work routines, organizational power, or even existence might be threatened by such market-based approaches. Within EPA, resistance has come from staff whose expertise in setting technology-based standards would become obsolete if the rules of the game were changed.[20] For example, market-based policies for controlling acid rain would not require the services of EPA engineers whose task in the current policy regime is to evaluate technologies for disparate sources of emissions across the country. Instead, decisions to select particular technologies to control air pollution would be left up to individual firms. In addition, there has been resistance from some in the environmental agencies who are simply skeptical toward new approaches that have not yet been applied on a large scale.

Third, there has been some resistance to market-based approaches from players in the legislative system who, having learned to use their influence to fine-tune a command-and-control regulatory system, are understandably reluctant to allow any major changes in the rules of the game. Thus, some lobbyists for both environmental organizations and the private sector, as well as some legislators, resist market-based approaches in part out of desire to protect the value of their expertise. The resistance from some industry lobbyists to putting these ideas into practice is especially notable given that the business community has long endorsed the theory of cost effective, market-oriented approaches to environmental protection.

Finally, the simple fact that many market-based approaches -- pollution charges in particular -- involve new taxes is problematic, given that taxes have been a controversial and often forbidden subject for much of the last decade in Washington. As we discuss, compensating reductions in other taxes can make pollution charges revenue neutral, and can improve the economic efficiency of the overall tax code. But many elected officials are wary of embracing such approaches, perhaps because voters and pundits might reasonably doubt that government would simply rebate revenues once it has collected them.

Of course, not all resistance to market-based environmental regulation flows from narrow self-interest. Some in the environmental movement may act out of a strategic sense that these approaches will make the costs of environmental protection more salient to the public and therefore dampen popular demand for such controls. Similarly, some in the legislative process may believe that the theories justifying pollution charges are too complex to attract broad popular support. Nevertheless, the fact remains that the U.S. has wasted many years and billions of dollars by moving so slowly to market-based approaches, for reasons that have more to do with narrow agendas than the public interest.

Over the past several years, however, a rapid evolution has occurred in the political debate on market-based incentives for environmental protection. The change flows from a number of factors that have combined to overcome some of the older sources of resistance. [21] These include: strong interest within the Executive Office of the President;[22] aggressive participation by some segments of the environmental community, notably the Environmental Defense Fund (EDF);[23]and the release of the bipartisan Project 88 report of Senator Timothy Wirth of Colorado and the late Senator John Heinz of Pennsylvania.
The Project 88 report, Harnessing Market Forces to Protect Our Environment, released in December of 1988, dovetailed with interest within the Administration, the Congress, the environmental community, and private industry, by proposing thirty-six policy recommendations that would enlist market forces to prevent pollution and reduce waste of natural resources. Two years later, Senators Wirth and Heinz sponsored a follow-up effort, Project 88/Round II, Incentives for Action: Designing Market-Based Environmental Strategies, focusing on the design and implementation of effective and practical market-based policy mechanisms for three particularly important challenges: global climate change due to the greenhouse effect; generation and disposal of solid and hazardous waste; and management of natural resources.

Now it appears that market-based systems are gaining an increasingly broad array of supporters. In the Bush administration, EPA Administrator William K. Reilly established an Economic Incentives Task Force to identify new areas in which to apply market-based approaches.[24] Congress also shows both increasing interest in and a new willingness to debate economic incentives; indeed, the phrase "market-oriented environmental policy" may itself be assuming some political value.

Congressional opportunities for adopting market-based schemes have recently been enhanced by the evolving support of the major environmental advocacy organizations. An increasing number of environmental groups now support market-based reforms. First and foremost, EDF, an early supporter of market-based environmental policies, continues as an enthusiastic and effective proponent of these ideas.[25]Other environmental groups that count economists among their senior staff members, such as the Wilderness Society and the National Wildlife Federation, have been supportive, although less vocal. A number of other prominent environmental organizations, including the National Audubon Society, the Sierra Club, and the Natural Resources Defense Council (NRDC), now support at least selective use of market-based instruments.

Market-based policies' ability to economize scarce resources has combined with a variety of other factors to bring these systems to center stage in environmental policy debates within the Congress. The debate at the Federal level has focused mainly on the potential of tradeable permits. As noted, the most important application to date has been the acid rain provisions of the 1990 amendments to the Clean Air Act.[26] Tradeable-permit systems have also been part of other Federal environmental policies, including EPA's Emissions Trading Program for local air quality[27]and the nationwide phase-down of lead in automotive.fuel.[28]

While state impediments and uncertainty about the future course of the Emissions Trading Program have sharply limited trading by firms, the limited trading that has occurred has saved more than $4 billion with no adverse effect on air quality.[29] According to EPA, the lead program, with much higher trading among firms, reduced overall compliance costs by approximately 20% (about $200 million annually).[30] Tradeable permit systems are now being proposed for a host of environmental problems, including: international trading in greenhouse gases; recycling targets combined with tradeable permits; and point- and nonpoint-source water pollution control.[31]

While permit systems have commanded the headlines in Washington, states and localities have expressed interest in other market-based environmental policies. "Bottle bills," a well-known type of "deposit-refund system" intended to reduce litter and promote recycling, have been particularly popular. The removal of market barriers to voluntary water transfers[32] has been an increasingly important policy innovation in the western U.S. Such transfers alleviate water supply problems and increase efficiency by creating incentives for water conservation. The most notable transfer plan to date has been the $223 million agreement between the Imperial Irrigation District (IID) of California and the Metropolitan Water District (MWD) of Los Angeles.[33] Under the agreement, MWD is

financing the modernization of IID's water system in exchange for the use of conserved water.[34] Finally, the Congress has moved to reduce government subsidies which cause economic distortions and environmental damages. Examples include recent reductions in the Federal subsidy given to U.S. Army Corps of Engineers flood- control projects (which provide incentives for individual landowners to convert forested wetlands to agricultural cropland[35]) and discussions in the Congress regarding the U.S. Forest Service's "below-cost timber sales," which recover less than the cost of making timber available.

Not surprisingly, the business community continues to speak in support of cost-effective, market-oriented approaches to environmental protection. General Motors, for instance, has endorsed the adoption of a broad-based carbon fee to limit emissions of greenhouse gases.[36] Other major corporations have expressed support for incentives, at least in principle.

The net result of this surge of interest in market-based incentives is a much broader awareness of the many options open to policy makers, both at Federal and local levels. It suggests that some of the political and bureaucratic sources of opposition to these approaches may be growing weaker. This transition appears to be, in part, generational; younger members of the environmental bureaucracy, many influenced by the "law and economics" movement within major law schools or products of professional public policy schools, seem to have a better understanding of market-based approaches.

Unfortunately, there remains a wide range of market-based initiatives that has largely been ignored. In particular, the potential of pollution charge systems has received scant attention when compared to other market-based instruments. Some of the inattention may be due to the same forces that for years impeded adoption of tradeable permits and similar approaches; some may simply be due to the perceived complexity of the concepts involved.

In either case, this lack of attention should now be remedied, since pollution charges have several distinct advantages over other policy instruments, especially for certain categories of environmental problems.

2. POLLUTION CHARGES: WHAT THEY ARE AND HOW THEY WORK

In this section, we describe the logic and mechanics of pollution charge systems, review the nation's experience with them, and discuss ways to use the revenues collected.

2.1 The Logic and Mechanics of Pollution Charges

Charge systems reduce polluting behavior by imposing a fee or tax on polluters. Ideally, the fee should be based upon the amount of pollution generated, rather than the level of pollution-generating activities.[37] In some cases, it may be based upon the expected or potential quantity of pollution.[38] A true pollution charge provides incentives to firms or consumers[39] to reduce "emissions" when that is less expensive than continuing to pollute.

Pollution poses real costs to society (for example, health consequences, property damages, and aesthetic impacts), but firms typically do not have to pay for these damages and hence face little or no incentive to take them into account in production decisions.[40] Pollution charges force firms to pay for the external costs of pollution and to incorporate those added costs into their daily decision making; in the parlance of economists, pollution charges lead firms to "internalize the externalities.

Pollution charges also provide strong incentives for firms to develop and adopt improved control technologies. Under command-and-control, firms face no financial incentive to perform better than the regulatory standard. Pollution charges, however, do not specify a technology or a fixed standard. Charges are incurred for each increment of pollution (rather than only for pollution above a given standard), constantly motivating firms to improve their financial performance by developing technologies that allow them to reduce their output of pollutants.

By charging producers of pollution a fee or tax on the amount of pollution they generate (not simply on their pollution-generating activities),[41] the government gives firms an incentive to reduce pollution up to the point at which their (marginal) costs of control are equal to their pollution-tax rates. As a result, firms will control to different degrees, with high-cost controllers controlling less, and low-cost controllers controlling more. An effective charge system thus minimizes the aggregate costs of pollution control, and enables the public to pursue higher levels of environmental quality than might have seemed affordable under less efficient approaches, such as command-and-control regulations [42]

2.2 Experience with Pollution Charges

The U.S. does not have much experience with true pollution charges, although a few state and local governments have been at the forefront of experimentation with this approach. As discussed later in this paper, for example, Seattle, Washington, has implemented an innovative and effective "green charge" strategy for pricing trash pick-up in order to reduce the volume of solid waste entering its landfills. A few Federal policies have embraced some pollution charge characteristics, but these have aimed primarily at generating revenue rather than discouraging pollution. In 1989, Congress enacted an excise tax on chlorofluorocarbons (CFC's),[43] which deplete stratospheric ozone and are potent greenhouse gases. As part of the Montreal Protocol and the subsequent London Revisions of 1990, the U.S. agreed with other nations to phase out all CFC's by the year 2000.[44] The U.S.'s primary mechanism for achieving its targets is a tradeable permit system; the excise tax does not materially affect either the level or rate of the CFC phasedown. It simply ensures that any windfall profits associated with constrained supply flow to the government rather than to private industry.[45]

The chemical and petroleum feedstock taxes that finance the cleanup of abandoned hazardous waste sites under the "Superfund" Act (the Comprehensive Environmental Response, Compensation, and Liability Act or CERCLA) are also not pollution charges;

Superfund levies taxes on production (i.e., it is revenue based), not emissions. As a result, there is no direct link between environmental controls undertaken and taxes paid, and therefore no direct incentive for pollution control. Indeed, the Superfund excise tax was designed as a mechanism for raising revenues, not as a market incentive for environmental protection.

Several European nations[46] have adopted air or water-pollution charge mechanisms. These systems function primarily to generate revenues rather than to discourage pollution,[47] but one partial exception is the Effluent Charge Law adopted by the Federal Republic of Germany in 1976.[48] For five pollutants, dischargers pay a set fee for each increment of actual emissions. [49]

2.3 What To Do With Green Charge Revenues

One major by-product of charge systems is a flow of money from polluters to the government. This financial transfer could be substantial; the Congressional Budget Office estimates that a $100 per ton charge on carbon dioxide emissions (to address global climate change) could result in over $120 billion in annual revenues to the government.[50] This raises the obvious question of how such revenue should be used.
There are at least three possible courses of action. The first option would be to use the funds to reduce the Federal budget deficit. This alternative has obvious appeal in an era of unprecedented levels of government borrowing. [51]

The second option would be to use the tax revenue to finance other programs related to environmental protection. Such programs might entail further clean-up or mitigation of pollution. They might also be directed to assisting those who are economically hurt by the change to a system of green charges. This latter use gets at an important point. While green charges are cost-effective, cost-effectiveness should not be the only criterion policy makers use to weigh policies. Questions of fairness and equity are also important, and often dominate political debate. Most environmental policies -- whether command-and-control or market-based - - require some trade off between efficiency and equity. Even when the aggregate benefits of a policy exceed its aggregate costs, there are usually some individuals or firms who are made worse off. These might include consumers who have to pay higher prices for goods and services, employees who are dislocated, or shareholders whose profits erode.

Whether and how to compensate such groups are political questions. But the answers often revolve around the availability of resources. One of the attractions of green charges is that they can provide the resources necessary to buffer their own impact on specific groups. For instance, if a green charge was used to raise energy prices (as will be discussed below), it could impose a particular burden on low-income households. Yet the revenue from the charge could be used to fund a system of "lifeline rates" -- free or discounted rates for the first units of energy consumed by a household. Similarly, revenues from a green charge that eliminated certain jobs could be used to fund job-

search and job-training programs. In addition, revenues from green charges might be used to compensate groups deemed to have been unfairly harmed by past environmental policies -- for example, to clean up toxic wastes that were dumped near a minority neighborhood whose residents were effectively disenfranchised at the time of the dumping.

The third option -- using pollution-charge revenue to offset reductions in other taxes -- may be the most attractive in many settings.[52] Pollution charges are "corrective" taxes, which actually reduce market inefficiencies by discouraging undesirable activities that generate externalities. This effect contrasts sharply with that of "distortionary" taxes, including corporate profit, Social Security and other payroll, and personal income taxes which tend to generate market inefficiencies.[53] The corrective nature of pollution charges provides a "double dividend:" [54] in addition to providing incentives to reduce pollution, pollution-charge revenues can finance reductions in distortionary taxes. This tradeoff is particularly important in today's political climate where policy makers are reluctant to consider any new taxes. A revenue-neutral tax policy change, combining the introduction of pollution charges with the reduction or elimination of other taxes, would protect the environment by reducing harmful emissions and reducing distortions associated with other taxes.[55] Such a shift in tax policy would tax, and thus discourage, socially undesirable activities (pollution) rather than socially beneficial activities (labor and capital formation).

3. POTENTIAL APPLICATIONS OF GREEN CHARGES

Pollution charges can address a variety of environmental problems through various levels of government. They work best when the central question is not whether but how much emission is acceptable, when margins of error are not particularly tight, and when emissions can be monitored at reasonable cost. The list of potential applications includes many forms of air and water pollution, as well as many solid and hazardous waste problems. In the remainder of this paper, we consider four particularly promising areas for action: greenhouse-gas reduction; motor vehicle fuel efficiency; solid waste reduction; and hazardous waste management.

3.1 Greenhouse Gas Reductions: The Potential Role of Carbon Charges

Few of the environmental problems that have arisen since the beginning of the industrial revolution have posed greater risks or greater uncertainties than the threat of global climate change due to the greenhouse effect. If emissions of carbon dioxide (CO_2) and other greenhouse gases (such as methane, nitrous oxides, and chlorofluorocarbons) continue to grow at current rates, many scientists believe that global mean temperatures may rise by 2 to 5 degrees Fahrenheit over the next century. Such an increase could cause widespread changes in precipitation patterns, storm frequencies and intensities, and ocean levels. [56]

International negotiations are focusing on how much to limit emissions and how to allocate the control burden among nations.[57] If national targets or standards are agreed upon, the United States must find ways to achieve its goals. Given the importance of CO_2 to the global warming phenomenon and the central role that CO_2-producing fossil-fuel combustion plays in our economy, cost-effective approaches would be an essential part of minimizing economic dislocations while complying with international agreements.
A properly designed CO_2 charge system could enable the U.S. to achieve a national CO_2 target cost effectively. Such a system would impose charges to increase the costs of CO_2 emissions.[58] The charge would vary by type of fuel (for example, coal, oil, and natural gas), depending upon the CO_2 emissions associated with it. The higher prices would internalize the anticipated costs of climate change.[59] This would reduce direct demand for fossil fuels, encourage conservation, lead to a more appropriate mix of resources, and stimulate the development of new, less carbon-intensive technologies. Both fossil-fuel use and emissions of carbon dioxide would decrease.

Because the goal is to reduce CO_2 emissions, the ideal charge system would, theoretically, be based upon the quantity of CO_2 emitted. Unfortunately the vast number of individual sources of CO_2 emissions makes such a system impractical. One alternative is a charge on coal, crude oil, and natural gas, based on the fuel's carbon content,[60] (carbon content is roughly proportional to the amount of CO_2 emitted upon combustion). This charge could be imposed at the point of entry for imported fuels and at the point of primary production for domestic fuels. There would be no need for additional charges on refined petroleum products or on other goods derived from fossil fuels.[61]

The CO_2 charge offers several advantages over conventional regulatory approaches. First, it would be far more cost effective. By encouraging the greatest reductions in CO_2 emissions by firms who can make those reductions most cheaply, a charge system could reduce total industry compliance costs. Its administrative costs would also be much lower than those of conventional regulatory standards that limit fossil-fuel burning by setting different standards for the thousands of industrial, commercial, and residential uses of each fuel. Determining, monitoring, and enforcing these standards would be very costly, to say the least. By contrast, a CO_2 charge would require essentially one tax rate for each fuel type. Second, CO_2 charges would create incentives for technological innovation, since firms could reduce their bill for CO_2 charges by reducing their fossil fuel consumption.

The charge level should be set to encourage reductions in CO_2 emissions sufficient to achieve the country's national targets. This is easier said than done. While it is clear that a carbon charge could significantly reduce fossil-fuel use, the relative impacts of different charge levels are very uncertain. Projections indicate that a $100/ton carbon charge, phased in over 10 years, would lead to reductions in U.S. CO_2 emissions of 8% to 36% by the year 2000,[62] relative to the emissions that would occur without a charge.[63] How large a carbon charge would be needed to drop CO_2 emissions to 20% below their 1990 levels? According to one rather pessimistic analysis,[64] a $200-$400 per ton charge would be

required to achieve such reductions between 2010 and 2040; maintaining emissions at this level for the longer term (2050 and beyond) would require a $250 per ton charge.
The impacts of a carbon charge on U.S. economic activity cannot be overlooked; if a phased-in $100/ton charge were unilaterally adopted by the U.S., it could lead to a 2 % annual loss in GNP (from baseline projections) by the time it was fully implemented. The impact would be substantially less if other nations acted in concert. In any event, a revenue-neutral charge that rebates the revenues from this CO_2 charge by reducing other taxes would greatly reduce the 2 % loss in GNP, and might offset it altogether.

Given the magnitude of the reduction targets frequently discussed by policy makers and the universal use of fossil-fuel energy in our economy, achieving greenhouse goals (such as a 20% reduction of CO_2 emissions) could entail very substantial costs, regardless of the policy instrument selected. Indeed, an advantage of pollution charges beyond their cost effectiveness is the fact that they explicitly clarify for the public the costs of environmental protection (and what the public must be willing to pay to reduce the risks of global climate change). One important question, however, is whether this burden will be evenly distributed across income classes. By some measures, lower income households spend a larger share of their incomes on fossil-fuel related products than do more affluent households. As a result, a carbon charge might hit these households harder. As discussed earlier, a revenue-neutral approach could mitigate some of the tax's impact on low-income households by providing "lifeline rates" for initial increments of energy use to reduce the pressure on low-income households. A further challenge concerns regional distribution of the charge; some regions of the country would likely bear larger burdens than others.[65] In particular, the high carbon content of coal, relative to other fuels, would translate into relatively greater costs/taxes for coal-producing regions.[66] It should be recognized, however, that regional impacts would be essentially the same if a conventional emission-standard approach were adopted.

3.2 Motor Vehicle Fuel Efficiency and Gasoline Taxes

Increases in gasoline taxes are frequently discussed as a way to deal with a broad set of environmental and other problems.[67] Given the wide coverage already given to such proposals in the national news media, we need not give much attention to specific benefits here, except to note that the appeal of this approach will depend upon the specific objectives being considered. A gasoline tax would be a legitimate instrument for dealing with some environmental problems closely related to the burning of gasoline, such as emissions of air pollutants.[68] Likewise, increased gasoline taxes could provide significant energy-security benefits by reducing the nation's overall demand for petroleum products,[69] and would tend to reduce highway congestion.[70] According to the Department of Energy, a 50 cent per gallon gas tax increase could eventually reduce gasoline consumption by 10% to 15%, reduce oil imports by 500 thousand barrels per day, and generate about $40 billion per year in revenue.

The fundamental mechanics of a gasoline tax are quite straightforward -- it is simply a charge added to the price of gasoline. When faced with higher prices, consumers will change their driving behavior in the short run and their vehicle-purchasing behavior in the long run, both in ways that lead to greater fuel efficiency. This approach could be far more effective than current proposals to increase the fuel-efficiency (CAFE) standards for new cars.[71] How changes in gasoline taxes would be administered depends upon policy objectives and political considerations. If the primary purpose is to address local pollution problems or traffic congestion, the charge is probably best levied by local or state authorities. If, on the other hand, the purpose is to address national or global environmental issues or national security issues, there are sound arguments in favor of a Federal program.

If our focus is purely on CO_2 emissions, a gasoline tax is likely to be less attractive than a carbon tax, since it is linked less directly with carbon emissions and would require one user group (gasoline consumers) to shoulder the burden. In principle, there may be arguments in favor of both a carbon and a gasoline tax, but the public may tolerate only one new Federal green charge initiative. Moreover, apart from issues of dependence on foreign oil and global climate change, most of the problems associated with gasoline consumption are regional or local (for example, smog and traffic congestion). Therefore, a pragmatic approach may be to focus on a carbon charge at the Federal level and leave consideration of gasoline taxes to the states.

The potential revenue neutrality of any change in gasoline taxes is important. If the tax were Federal, transferring the revenue from the gas tax to the Social Security Trust Fund and crediting it to current workers might address the greatest concern about higher gas taxes -- they can hit hardest on working families and particularly on workers who drive to their jobs. If $40 billion per year from a 50C/gallon gas tax were paid into Social Security, the payroll tax -- the employee contribution to Social Security -- could be cut by almost a third: a worker with annual wages of $30,000 would take home an additional $700 per year. The extra income would more than offset the cost of the gas tax, unless the worker drove over 35,000 miles per year (in a car getting 25 miles or less per gallon). A tax of this magnitude could also be phased in gradually, perhaps no more than 10 cents per year over 5 years, allowing individuals and firms to adjust their consuming and producing behavior. While such a scheme is not a panacea for all energy and environmental problems, it could make a significant contribution.

3.3 Solid Waste Management

The increasing volume of solid waste our society generates has emerged as a pressing problem in many parts of the United States over the past decade. Many areas are running out of landfill space[72] and many communities have effectively blocked the construction of new facilities. This space squeeze, in conjunction with tighter landfill regulations, has significantly increased the cost of disposal in many parts of the country. In the Northeast, tipping fees (disposal charges) are now as high as $125 per ton. Nationwide, tipping fees rose over 26% annually between 1984 and 1988.[73] While some communities have turned

to incineration of these wastes, concerns exist that garbage burning contributes to air pollution and that the ash it generates poses its own disposal problems. Pollution charges offer a way to use the market to address the waste problem naturally and cost-effectively.

The difficulties of providing safe and adequate disposal have led many to call for reductions in the amounts of solid waste generated. Doing this cost effectively can be a complex task, as the appropriate strategies vary by both type of material and geography. While greater recycling may be the best alternative in some cases or locales, high costs of collection and separation, distant processing facilities, and/or inadequate technologies may make it prohibitively costly in others. Practical strategies must also match consumer needs. For instance, separating recyclable materials can be time-consuming, particularly when materials must be brought to a transfer station. While some consumers may be willing and able to undertake this activity, it will represent a significant burden for others.

Most waste reduction efforts to date have used conventional command-and-control regulations. In some cases, states and municipalities have enacted draconian measures such as product bans or across-the-board recycled-content standards for packaging with little regard for costs or consumer preferences. These policies have raised costs, despite having little effect on the amount of solid waste generated. Indeed, a lack of markets for old newsprint caused many communities with mandatory separation requirements to store or even landfill their collected newspapers.[74]

Flawed pricing mechanisms for waste disposal are at the core of most solid waste problems. Pricing mechanisms that do not reflect the total cost of disposing of the wastes lead to over-generation of waste and inefficient mixes of disposal and recovery methods. If these distortions are eliminated, the market can provide proper incentives for waste reduction and recycling without resorting to cumbersome and distortionary measures such as product bans and mandatory separation.

The pricing problem has several dimensions. First, most individuals and firms never directly "see" the costs of waste disposal. In many communities, these costs are simply imbedded in local property or income taxes. Some cities have made the costs of waste disposal more apparent to consumers by "unbundling" these costs from other municipal services; that is, citizens pay a separate charge for waste collection. Unfortunately, even these charges do not provide incentives for decreasing the amount of waste; they are typically fixed --flat monthly payments that do not vary with the quantity of waste generated.

With such pricing systems, it is not surprising that the "throw-away ethic" has thrived. The cost of throwing away an additional item of refuse is essentially zero; residents merely place their empty bottles, cans, lawn clippings, and other wastes in a trash chute or at the curbside and they magically "disappear" when the municipality or contractor picks them up. Imagine what kind of cars we would buy and how much we would drive if our total annual bill for gasoline were independent of the quantity of gasoline we used. This is essentially what is happening today with municipal solid waste management in almost all communities in the United States.

Effective waste management strategies must "get the prices right" -- they must communicate to consumers the true total social cost of throwing things away. They must create incentives for consumers to generate less waste -- either through greater recycling and greater reuse of materials, or by demanding less wasteful packaging and products from manufacturers. Decisions of individuals and firms should reflect the incremental costs of waste disposal. These costs can be inserted at any point in the product life cycle. At least three incentive-based approaches already exist: (1) curbside waste collection charges at the point of disposal; (2) retail disposal charges at the point of sale; and (3) virgin material taxes in the production process itself.

Unit Pricing for Municipal Solid Waste Disposal

The first option for addressing solid waste problems explicitly links household charges to the real costs of collection and disposal; it charges citizens for the specific quantity of waste they generate. Its rate structure should reflect not only the costs of pick up, but also associated tipping or incineration fees. These fees motivate households to reduce the quantities of waste they generate, whether through changes in their purchasing patterns, reuse of products and containers, or composting of yard wastes. Furthermore, placing different unit charges on unseparated refuse and specified, separated recyclables can induce households to separate the recyclable components of their trash. Such household unit pricing for collection and disposal can provide incentives at the community level for a cost-effective mix of waste disposal alternatives -- landfilling, incineration, and recycling.[75]

The charge can be based on either volume or weight. Most initial forays into unit pricing bill households for the number and size of trash receptacles they use. In Seattle, Washington, customers choose from four sizes of receptacles, ranging in price from about $11 per month for a 19-gallon container to almost $32 per month for a 90-gallon container. The program appears to be having its intended effect: in 1979, the average family was setting out approximately four 30-gallon containers per week; by 1989, 87% of households subscribed to one 32-gallon container or less.[76]

One potential problem with per-can pricing is that customers are charged for a full can even if it is not used or only partially filled in a particular week. "Bag and tag" systems avoid this problem. Under such systems, households dispose of unseparated refuse only in specially designated trash bags sold by the municipality. Another approach involves the sale of stickers which are placed on cans or bags of specified dimension. In Perkasie, Pennsylvania, where the "bag and tag" approach was adopted, the total amount of solid waste collected fell by 60% in the program's first year of operation, and total collection and disposal costs decreased by 40%.

Another approach is to charge customers by the weight of their refuse. Under such a system, the un-separated waste is weighed at the collection truck and a bill is either left with the customer or sent later. This avoids the need to register cans or administer a bag-sales program. It also eliminates the advantage of possessing a trash compactor. The

major disadvantage of such a system is that investment may need to be made in new or remodeled garbage trucks.

A number of communities have combined unit charges for un-separated refuse with curbside collection of recyclable materials. This lowers the direct cost of recycling to consumers and gives them additional control over their waste charges. Some communities provide curbside recycling services free of charge, but this is by no means always desirable. The rate for collecting recyclable materials should, theoretically, be equal to the cost of transportation and program administration less the value of recyclable materials (whether positive or negative). But charging less for some recyclables or providing refunds at the curbside raises administrative costs dramatically above those of a system that charges for mixed refuse and provides free pickup for some recyclables. The latter combination can provide strong incentives for separation without significantly increasing administrative costs.

While experience with unit pricing to date indicates that it can significantly reduce waste generation, concern naturally arises about the policy's fairness to low-income households who would pay greater shares of their income for pick-up services than would higher income households. Surprisingly, unit pricing tends to be less regressive than conventional payment systems, although there is substantial variation among communities.[77] The Seattle system uses a tactic similar to the low "life-line rates" provided by electrical utilities for initial blocks of power usage -- customers pay only the fixed cost of curbside pick-up for their first 32-gallon container.

Unit charges may also lead to increased illegal dumping. The experiences of Seattle, Perkasie, and other communities suggest, however, that properly designed systems can prevent this problem.[78] New programs can be introduced incrementally, with charges rising gradually until they equal the true marginal costs of disposal. Municipalities can remove much of the incentive for illegal dumping by providing free or very low-cost disposal at transfer stations. Multi-unit dwellings, where residents dispose of their waste anonymously and get a "free ride" on the charges paid by others, represent a more serious limitation of unit pricing.[79] Charges at the building level will, however, provide an incentive to landlords or condominium managers to encourage residents to reduce wastes and ensure that the total waste generated will bear the costs of its disposal. Although the design and implementation of curbside charges must be undertaken at the local level, EPA could serve as a clearinghouse of information.

Retail Disposal Charges

Unit charges incorporate the costs of disposal at the point of refuse collection. An alternative approach administers these disposal costs at the point of product purchase. One mechanism for doing this is a retail disposal charge, by which communities place surcharges on the sale of items that reflect their costs of disposal.[80] Retail charges can act as a substitute for unit curbside charges when the latter are impractical (for example, in a community with many large, multi-unit residences). Retail charges can also serve as a

supplement to curbside charges for specific products whose disposal costs are well in excess of the costs associated with their volume. These might include household products whose ingredients have significant environmental consequences when they find their way into landfills or incinerators. Examples include electrical-appliance batteries, inks, paints and paint solvents, and household pesticides.

There are limitations on the practicality of a broad-based retail charge system. First, such programs will probably be considerably more complicated than curbside charges, with higher attendant administrative costs. In addition, politically feasible charges may be too small to influence consumer buying behavior sufficiently.

Responsibility for setting the charge level should rest with municipalities or metropolitan areas. Because disposal costs vary greatly by geographic area, disposal charges applied to retail products should likewise vary. However, gathering the necessary information on product composition would be a daunting task for any single community. Given the national scope of most product markets and the economies of scale in collecting and aggregating data, the Federal government is probably best suited to this task.

Virgin Materials Taxes

Incorporating disposal costs at the point of production is a third alternative for improving price signals for solid waste management. Placing charges, which reflect ultimate costs of disposal, on virgin materials would encourage switching to materials and products with lower costs of disposal. This approach would favor recycled materials, since the costs of virgin materials would rise more than those of secondary ones.

Virgin material charges are likely to be a much more cost-effective approach to encouraging recycling than the recycled-content standards that have recently been established in several states. For example, California, Connecticut, Maryland, Missouri, and Wisconsin have all enacted legislation requiring publishers to increase their use of recycled newsprint. Similar legislation has been proposed in Illinois, New Jersey and New York. [81]

Virgin material taxes ought to be viewed as potential substitutes for unit curbside charges or retail disposal charges; a system that added one on top of the other could create double taxation. A clear disadvantage of virgin material charges is their insensitivity to local conditions. Since charges would need to be computed on a standardized national basis, they should only be applied to a few materials that are particularly large contributors to solid waste problems.[82] If charges reflected average conditions, consumers in low-disposal-cost areas would pay too much for given products, while those in high-disposal cost areas would not pay enough. Therefore, while virgin material charges might create more demand for recyclable materials than most conventional attempts, they are not likely to be as effective as unit curbside charges in encouraging the right mix of recycling and disposal technologies for each community.

3.4 Hazardous Waste Management: Deposit Refund Systems

Improved price signals can reduce the volume of waste reaching landfills and incinerators. In some cases, however, the problem is the toxicity of the waste, not just its volume. In general, as more stringent regulation increases the costs of legal disposal, incentives for improper disposal rise. Hence, waste-end fees designed to cover the costs of disposal can lead to an increased incidence of illegal dumping. This is not a problem with unit curbside charges for solid waste, because neither the quantity of dumping nor its consequences is severe. For some wastes, however, ex post clean up is much less attractive, due to significant health risks or ecological consequences. Such wastes include not only industrial by-products but consumer goods such as lead-acid batteries and lubricating oil. When these products enter the waste stream they can subsequently contaminate water supplies or generate air pollution.

Front-end taxes (virgin materials taxes and the retail disposal charges), which we examined earlier, give firms and individuals incentives to find safer substitutes and to recover and recycle taxed material. But such charges, if levied on hazardous materials, may encourage some firms to circumvent the process through illegal emissions ("midnight dumping"). And such systems do not provide incentives to change disposal methods. Deposit-refund systems, on the other hand, potentially represent a cost-effective way to manage these and other categories of toxic wastes. They create incentives for firms and individuals to dispose of wastes properly and to search for more benign substitutes.

Deposit-refund systems combine a special front-end charge (deposit) with a refund payable when quantities of the substance in question are turned in for recycling or proper disposal.[83] This refund provides an incentive to both follow the rules for proper disposal and minimize substance loss during production. The deposit is paid to a government agency, which holds it for ultimate refund. As the product changes hands (for example, from manufacturer to distributor to customer), the purchaser pays a deposit to the seller. The ultimate consumer of the good brings the product to a certified collection center responsible for recycling or proper disposal.

Deposit-refund systems are particularly useful when the improper disposal of waste, rather than its generation per se, is of concern. The initial charge can be levied either as a material enters the production system or at any point in the manufacturing, distribution, or sales process, depending upon the specific circumstances.

Deposit-refund systems offer several potential advantages. First, they ease the government's often impossible task of tracking and controlling waste generation and disposal (as it presently exists under the Resource Conservation and Recovery Act -- RCRA). Instead, the government would only ensure that deposits are collected and that the materials returned for refund are what they purport to be. Deposit-refund systems also encourage firms to prevent net losses of targeted materials in the production process. This motivates firms to search for less environmentally damaging substitutes. [84]

Although deposit-refund systems have been applied primarily at the state level, a Federal approach will be appropriate for some substances and problems. This would be true when firms face national markets with easily transportable products and when the consequences of improper disposal do not vary significantly from one location to another. Geographic homogeneity of charges also reduces the cost and complexity of control, both to firms and to administering agencies.

Deposit-refund programs have been proposed for a variety of materials, including vehicle tires and car bodies. The strongest case can be made, however, for products with very high costs of improper disposal; in such cases the costs of separation and redemption are usually outweighed by the benefits of proper disposal. The best regulatory sequence may involve initial experiments with deposit-refund systems for toxic but not officially "hazardous" wastes. As such systems are perfected, they may alter or replace parts of the "cradle-to-grave" tracking system of RCRA. Deposit-refund systems would eventually focus on a variety of products, including lead-acid batteries, certain industrial chemicals (for example, chlorinated solvents), and used lubricating oils.

Lead-Acid Batteries: The amount of lead which enters landfills and incinerators is still a major concern. Most of this lead is in storage batteries. Although a substantial amount of lead from motor-vehicle batteries is recycled each year, the share of batteries recycled has been decreasing during the last 30 years.[85] At present, over 20 million unrecycled batteries enter the waste stream annually; this number may increase by more than 30% by the year 2000.[86]

Under a deposit-refund system, a deposit would be collected as a tax when manufacturers sold batteries to distributors, retailers, or original equipment manufacturers; retailers would collect their deposits by returning their used batteries to redemption centers; these redemption centers would, in turn, redeem their deposits from the administering agency. A national program could be designed to accommodate existing deposit systems for batteries, such as those found in Maine and Rhode Island. The deposit must be large enough to encourage a substantial level of return but small enough to avoid a significant theft problem. Another option for deterring theft would require sales receipts to claim deposits.[87]

Industrial Solvents: Deposit-refund systems may be a cost-effective instrument for ensuring safe management and disposal of certain "containerizable" hazardous chemicals -- for the most part, liquid chemicals stored in metal drums. About 30% of industrial wastes are types which may be generated in small enough quantities per unit to be containerized. Of those, almost half are waste types such as solvents and oils which are potentially recyclable after reclamation or re-refining. Because it is difficult to keep track of containerizable wastes, they are particularly hard to manage. If an industrial plant uses a metal degreasing solvent in its production process, for example, monitoring emissions to the environment of spent solvent requires checking all shipments out of the plant gates. For even a single plant, there can be thousands of "sources," each very small but collectively significant.

Deposit-refund systems hold promise for managing and disposing of certain hazardous chemicals more cost-effectively. One category of such chemicals is chlorinated solvents. While most chlorinated solvents are recycled to some degree by the thousands of firms using them, substantial amounts still reach the environment. Some of the solvent escapes in the production process and is released into the atmosphere; more seriously, highly contaminated spent solvents are often not economical to recycle and may be illegally dumped to avoid disposal costs.

Under a deposit-refund system, a deposit would be paid on each unit of solvent purchased from distributors. Firms could recover this deposit by returning spent solvent to designated recycling facilities (which presumably pay the deposit plus the amount normally offered for spent solvent). Improper disposal would be discouraged since firms would be motivated to recoup their deposits, and minimize on-site losses by either installing equipment to control vapor losses or substituting new materials and processes. For solvents that are incorporated into products (for example, methylene chloride used in aerosols), the deposit would act as a front-end tax which would reflect the social costs of the solvent's use, thus encouraging firms to seek alternatives.

The administrative complications associated with such a program should not be underestimated. Verification would be an important issue, since a deposit-refund system could encourage users to dilute solvents. Even in the absence of any deliberate dilution, waste products vary in terms of their solvent content, ranging from sludges to chemicals the consistency of water. Testing of solvent shipments would be needed to determine the appropriate refund.[88]

Used Lubricating Oil: Used motor-vehicle motor oil is an environmental problem currently unaddressed by Federal regulations, except on an after-the-fact basis under "Superfund." The improper disposal of lubricating oil has both health and ecological consequences: when it is dumped into storm sewers or placed in unsecure landfills, it can contaminate ground and surface water supplies; when it is burned as heating fuel, it produces air pollution. At present, about 30% of lubricating oil is recycled; more important, only 5% of the 14% of used oil generated by individuals ("do-it-yourselfers") is typically recycled. These consumers exhibit by far the highest incidence of improper disposal.[89]

Enforcing proper disposal of lubricating oil through conventional regulations would be exceedingly costly, since hundreds of thousands of firms and millions of consumers would have to be monitored. A deposit-refund system promises to be much more cost-effective.[90] The simplest version of such a program would require consumers to pay a deposit to retailers for each quart of oil purchased; they could receive a refund by returning the used oil to redemption centers. Redemption centers would either sell used oil to recyclers or ensure proper disposal. The program could be expanded to include more segments of the market, such as service stations and commercial fleets, by imposing the deposit at the point of manufacture. A serious problem with the deposit-refund

approach for lubricating oil, however, would be difficulties (costs) associated with detecting counterfeit substances.

3.5 Other Potential Applications of Pollution Charges and User Fees

The systems described in this paper are just four examples of how pollution charges and user fees can deal with contemporary environmental problems; many other potential applications exist. For example, a charge, based upon environmental damage potential, could be placed on the sales of pesticides and other agricultural chemicals. This would encourage farmers to use these chemicals more efficiently and would provide strong incentives for manufacturers to find less environmentally harmful substitutes. Such a charge could help address the difficult problem of non-point source water pollution.

Similarly, the United States could follow the example of Germany and impose effluent charges on water pollution. Such charges could encourage firms to reduce emissions below levels currently allowed through discharge permits. Emissions charges could also be used for many air pollutants, even where standards are already in place. One such example proposed by the EPA Economic Incentives Task Force is for fees on major stationary sources of volatile organic compounds (VOC's), precursors of urban smog.[91]
A set of related policies could help address environmental problems associated with automobile use in major cities. In particular, "congestion pricing" could be used to charge drivers a toll for rush-hour trips, based upon existing electronic-scanner technology.[92] Other mechanisms that could reduce the total miles traveled in automobiles and therefore air pollution include: employee parking charges; increased charges for public parking; and smog taxes, as described above.

In the area of resource management, more emphasis could be placed on user fees for our national parks and forests. Such schemes may be critical in weaning forest managers away from their dependence on timber revenues. [93] Estimates place recreational use at 41% of gross U.S. Forest Service forest value, making it the single most valuable forest use, but recreation generates only 3 % of Forest Service revenues. Substantial precedent suggests that users of publicly-owned natural resources should pay for a portion of the benefits they receive. [94]

4. POLLUTION CHARGES IN THE POLITICAL ARENA

No single policy mechanism -- neither incentive-based policies in general nor pollution charges in particular -- can be an environmental panacea. Pollution charges, however, promise to provide cost-effective solutions for some pressing environmental problems while spurring technological advances.

We have examined practical opportunities to apply pollution-charge mechanisms to four problems: greenhouse gas emissions; motor-vehicle fuel efficiency; solid waste management; and hazardous waste management. Throughout, we have emphasized how green charges can overcome the pitfalls of conventional regulatory approaches.

Cost effectiveness and feasibility are likely to be of paramount importance in any successful policy that addresses the apparent causes of global warming, which are ubiquitous in our economy. If goals for controlling CO_2 emissions are set by an international agreement, they must be achieved at the lowest possible cost. Given the millions of CO_2 sources, which would have to be controlled, it is difficult to imagine how conventional regulatory approaches could provide meaningful results. Thousands of separate standards would have to be promulgated and monitored, or the policy focus narrowed to a few sectors of the economy; either scenario raises costs dramatically. Pollution charges, on the other hand, provide a feasible alternative for reaching CO_2 emission reduction objectives at the lowest possible cost to society.

Similarly, gasoline taxes can be an effective way to reduce air pollution and traffic congestion. In many ways, such taxes would be a better approach than CAFE standards -- basically, a command and control strategy.

In the case of municipal solid waste management, charge systems can provide for better mixes of resource-use and disposal options. Conventional approaches typically dictate behavior through fiats and common standards, attempting to homogenize inherently heterogeneous circumstances. What makes sense in one area (for example, greater recycling) simply may not make sense in another; as a result, conventional approaches often misallocate resources. Pollution charges recognize variations in local circumstances; by changing relative prices to ensure that each individual citizen or firm bears the full environmental costs of their actions, charges lead automatically to an optimal mix of resource-use and disposal/recovery options.

Finally, in the case of hazardous waste management, conventional approaches may not only be administratively burdensome, but may actually encourage undesirable behavior such as underreporting or illegal disposal. Deposit-refund systems, on the other hand, discourage dumping and reduce monitoring demands on government by making it in the financial self-interest of firms and consumers to dispose of waste properly.

Good ideas are not self-adopting. Even if the new Clean Air Act provisions have signaled the beginning of a new era of environmental policy that does not mean that all resistance to market-based approaches has disappeared. In addition to opposition from those who simply oppose environmental protection, green charge proposals will have to overcome the same combination of self-interest and suspicion from those within the environmental protection process that has obstructed market-based approaches for decades.

Initially, the most practical path may be to apply pollution charges to new problems for which policy mechanisms are not already in place. This will minimize disruptions to industry and consumers, reduce the chance that regulations will work at cross purposes, and challenge the authority of fewer vested interests. If pollution charges turn out to be as effective as theory would suggest, they could be considered as alternatives to some of the environmental regulations in place today, especially those that are deemed to be ineffective or that achieve their objectives only at extremely high costs to society.

Advocates of green charges will also be able to cite the growing record of experience that is being developed in the states. A broad array of state and local initiatives may help make the case that green charges can overcome public dislike for taxes (since their primary aim is not raising revenue but limiting pollution), while reducing the costs of environmental protection and stimulating technological development.

Ultimately, the greatest service that green charges may render is to bring environmental policy formulation "out of the closet." The American population has always been shielded from many of the very real trade-offs involved in establishing our environmental goals and standards. Policy formulation has been shrouded in technical complexity, which frequently obscures the more basic choice of how much economic well-being we are willing to sacrifice for increased environmental quality. Conventional regulatory approaches impose costs on industry that are not readily visible (but are partially passed on to consumers). Because neither policy makers nor citizens can see how much they are really paying for given levels of environmental protection, they have little basis for weighing relative risks.

Pollution charges can bring these important tradeoffs into the open by making the incremental costs of environmental protection explicit. As a result, policy discussions can move away from a narrow focus on technical specifications to a broader consideration of goals and strategies. This shift should help get the American public involved in constructive debates regarding the desirable level of environmental protection. In this way, the public can recapture the critical decisions of environmental goal-setting from bureaucrats, technicians, and special interest groups.

Promoting the selective use of pollution charges will require political courage; but it is the right thing to do for a variety of environmental problems, for both environmental and economic reasons. Furthermore, it offers potential political dividends: the underlying logic of pollution charges can be explained simply to the public; their basic principles will resonate well with Americans' fundamental sense of fairness -- "the polluter ought to pay."

Even without such political leadership, we may eventually be compelled to adopt these new approaches. As new environmental problems arise and old ones persist, the limited resources of government agencies and society at large will be stretched further and further. Pollution charges and other incentive-based instruments may ultimately be the only feasible courses of action if we hope to sustain or improve environmental quality while maintaining economic well-being. With the necessary political leadership, we can begin to move in the right direction now, before we reach such breaking points.

APPENDIX:
COMPARING CHARGES WITH TRADEABLE PERMITS

Although Washington has recently expressed great enthusiasm for tradeable-permit systems, neither permits nor charges nor any other incentive-based or command-and-control mechanism can be a panacea for all environmental problems. It is important to compare tradeable-permit approaches and pollution charges to highlight the circumstances under which each is likely to be most appropriate.

(1) Permits fix the level of control while charges fix the marginal costs of control. Under a permit system, policy makers determine how much total pollution can occur (through the issuance of permits), but they do not and cannot set bounds on spending for pollution control. This strategy could be particularly appropriate for environmental problems in which health or other consequences are thought to rise precipitously once they exceed a certain level, or ones with marginal costs of control that do not rise dramatically with increasing regulatory stringency. Charges, on the other hand, control the maximum amount that a firm may pay for each increment of emissions, but do not dictate with certainty how much control will actually occur. Such a tactic may be more appropriate where the margin of error on damages is not tight but where the potential industrial impacts of "over-control" are especially great. This could occur, for example, where small increases in control costs lead to very large swings in production and employment.

(2) Short of additional government intervention, permits freeze the level of control while charges increase it over time, in the presence of technological change. With a tradeable permit system, technological improvement will normally result in lower control costs and falling permit prices, rather than declining emissions levels. Such technological change under a charge system, however, will lead to both lower total control costs and greater reductions in pollution. As technological change pushes the costs of controlling emissions down, firms will choose to control more emissions and pay less taxes. [a]

(3) With permits, resource transfers are private/private while they are private/public with pollution charges.[b] Under permit trading, firms choosing to emit pollution beyond their initial permitted level must make payments to other firms who agree to control more than their share. With charges, payments for uncontrolled emissions flow to government. If the private sector can utilize these resources more effectively, permits offer an advantage over charges. Alternately, the government can earmark the revenue from charges for environmental investments, deficit reduction, or reductions in distortionary taxes.

(4) Both charges and permits impose costs on industry and consumers -- one is explicit, the other is implicit. Both charges and permits force firms to internalize the costs of their pollution. Practically speaking, this means that firms will spend more money for environmental purposes, either for pollution control equipment, or for cash payments for permits or green charges. A charge system, however, makes these costs visible to both industry and the public. While this may be politically problematic in the short-term, it clearly signals and educates the public about the costs and tradeoffs associated with various levels of environmental control.

(5) Permits adjust automatically for inflation, while charges do not. Because the "currency" under a permit system is emission rights, levels of emission control are unaffected by price movements in the overall economy. This is not the case for pollution charges. General price inflation will have the effect of reducing taxes (which are expressed in dollars per ton, for example) in real terms. Thus, in an inflationary environment, firms will control less. One means of remedying this would be to link the charge rate to some price index.

(6) Transaction costs can be important; they depend partly upon the number of firms in the market. Transaction costs (for example, costs associated with identifying willing buyers and sellers of permits, or costs of tax collection) not only have the effect of driving up the total costs of compliance for incentive-based mechanisms, but also affect the amount of trading that will occur in a marketable-permit system and the amount of pollution control a charge system will achieve. The relative magnitude of transaction costs is another important determinant when choosing tradeable permits or charges for any specific situation.

(7) Permit systems may be more susceptible to "strategic" behavior. In order for a permit system to work effectively, relatively competitive conditions must exist in the permit (and product) market. The degree of competition will help determine the amount of trading that occurs and the cost savings that will be realized. Should any one firm control a significant share of the total number of permits, their activities may influence permit prices.[c] Firms might attempt to manipulate permit prices to increase their profits in either the permit or final product market (for example, by withholding permits and forcing other firms to cut production or keeping new entrants out).

ENDNOTES

[*]Stavins is an Assistant Professor of Public Policy and a Senior Research Associate, Center for Science and International Affairs, at the John F. Kennedy School of Government, Harvard University, and a University Fellow of Resources for the Future; Whitehead is a Management Consultant at McKinsey & Company, Inc. This paper was prepared on behalf of the Progressive Policy Institute, Washington, D.C. The manuscript benefited from comments by Jeremy Rosner of the Progressive Policy Institute and editorial assistance by Sarah Smith-Lee. The authors alone are responsible for any remaining errors.

[1]For example, when the health-based "primary" ambient standards for "criteria air pollutants" are set under the authority of the Clean Air Act, costs of meeting standards may not, according to law, be taken into consideration.

[2]See: United States Environmental Protection Agency. Environmental Investments: The Costs of a Clean Environment. Report of the Administrator to the Congress of the United States. Washington, D.C., December 1990. This estimate excludes environmental activities not directly associated with pollution control or cleanup, such as wildlife conservation and land management. The $100 billion estimate covers spending by private business (63.0%), local governments (22.5%), the Federal government (11.0%), and state governments (3.5%).

[3]For an analysis of the impact of environmental regulation on productivity, see: Jorgenson, Dale and Peter Wilcoxen. "Environmental Regulation and Economic Growth." Rand Journal of Economics 21(1990):314-340.

[4]See: Reilly, William K. "Our Market Environment." Presentation at the Forum, "Market-Based Strategies for Environmental Protection -- A Tribute to Senator John Heinz." John F. Kennedy School of Government, Harvard University, Cambridge, Massachusetts, May 16, 1991. CSIA Report 91-6, September 1991.

[5]See: Stavins, Robert N., ed. Project 88: Harnessing Market Forces to Protect Our Environment - Initiatives for the New President. A Public Policy Study sponsored by Senator Timothy E. Wirth, Colorado, and Senator John Heinz, Pennsylvania. Washington, D.C., December 1988; and Stavins, Robert N., ed. Project 88 - Round II: Incentives for Action: Designing Market-based Environmental Strategies. A Public Policy Study sponsored by Senator Timothy E. Wirth, Colorado, and Senator John Heinz, Pennsylvania. Washington, D.C., May 1991. The descriptions of potential applications of pollution-charge mechanisms, presented in part 3 of this paper, draw, in part, upon the Project 88 -- Round II report.

[6]This section of the paper draws, in part, upon: Hahn, Robert W. and Robert N. Stavins. "Market-Based Environmental Regulation: A New Era From An Old Idea?" Ecology Law Quarterly 18(1991):1-42.

[7]Because of this focus, we consider issues of cost-effectiveness -- achieving a given goal or standard at minimum cost, but we exclude questions of efficiency -- selecting that goal which maximizes the difference between benefits and costs.

[8]Usually, regulations do not explicitly specify the technology, but establish standards on the basis of a particular technology. In situations where monitoring problems are particularly severe, however, technologies are specified.

[9]In a survey of eight empirical studies of air-pollution control, Tietenberg found that the ratio of actual, aggregate costs of the conventional, command-and-control approach to the aggregate costs of least-cost benchmarks ranged from 1.07 for sulfate emissions in the Los Angeles area to 22.0 for hydrocarbon emissions at all domestic DuPont plants. See: Tietenberg, T. H. Emissions Trading: An Exercise in Reforming Pollution Policy. Washington, D. C.: Resources for the Future, 1985.

[10]Numerical examples of the variance of incremental costs of air-pollution control are provided by: Crandall, Robert W. "The Political Economy of Clean Air: Practical Constraints on White House Review." Environmental Policy Under Reagan's Executive Order: The Role of Benefit-Cost Analysis, ed. V. Kerry Smith, pp. 205-225. Chapel Hill: The University of North Carolina Press, 1984.

[11]The marginal costs of pollution control are the additional or incremental costs of achieving an additional unit of pollution reduction. If these marginal costs of control are not equal across sources, then the same aggregate level of pollution control could be achieved at lower overall cost simply by reallocating the pollution control burden among sources, so that the low-cost controllers controlled proportionately more and the high-cost controllers controlled proportionately less. Additional savings could theoretically be achieved through such reallocations until marginal costs were identical at all sources.

[12]For an analysis of the problems of EPA's historical focus on technical questions, see: Landy, Marc K., Marc J. Roberts, and Stephen R. Thomas. The Environmental Protection Agency: Asking the Wrong Questions. New York: Oxford University Press, 1990.

[13]See: Hahn, Robert and Roger Noll. "Designing a Market for Tradeable Permits." Reform of Environmental Regulation, ed. Wesley Magat, pp. 119-146. Cambridge: Ballinger, 1982.

[14]See: Willey, Zach and Tom Graff. "Federal Water Policy in the United States -- An Agenda for Economic and Environmental Reform." Columbia Journal of Environmental Law 13(1988):325,349-351; and Chapter 4 of Project 88 -- Round II.

[15]See: Bowes, Michael D. and John V. Krutilla. Multiple-Use Management: The Economics of Public Forestlands. Washington, D. C.: Resources for the Future, 1989; and Chapter 4 of Project 88 -- Round II. Other examples of economically inefficient and environmentally disruptive subsidies include those associated with U.S. Army Corps of Engineers flood control projects, U.S. Bureau of Reclamation projects, and Bureau of

Land Management and Forest Service public lands grazing programs. On these, see: Hahn and Stavins, op. cit., 1991.

[16]See, for example: Dales, J. H. Pollution, Property, and Prices. Toronto: University of Toronto Press, 1968.

[17]For further discussion of these points, see: Hahn and Stavins, op. cit., 1991.

[18]See: Alm, Alvin L. "The Post-regulatory Environmental Protection Regime." Environmental Science and Technology 23(1989):1338-1339.

[19]See, for example: Hahn, Robert W. and Gordon L. Hester. "Marketable Permits: Lessons from Theory and Practice." Ecology Law Quarterly 16(1989): 361-406.

[20]See: Baden, John and Richard Stroup, eds. Bureaucracy vs. Environment: The Environmental Costs of Bureaucratic Governance. Ann Arbor: University of Michigan Press, 1981.

[21]For a discussion of the factors leading to the increased attention given to economic instruments, see: Hahn and Stavins, op. cit., 1991.

[22]See: Hahn, Robert W. "The Politics and Religion of Clean Air." Regulation, Winter 1990.

[23]See: Krupp, Frederic. "New Environmentalism Factors in Economic Needs." Wall Street Journal, November 20, 1986, p. 34.

[24]The final report of the Task Force was published in March 1991. See: U.S. Environmental Protection Agency. Economic Incentives: Options for Environmental Protection. Office of Policy, Planning, and Evaluation, Report Number 21P-2001, Washington, D.C., 1991.

[25]EDF was a major participant in the Project 88 effort and EDF economist Daniel Dudek worked closely with the White House staff to develop the administration's Clean Air Act proposal.

[26]Clean Air Act Amendments of 1990, Public Law No. 101-549, 104 Statute 2399 (1990).

[27]See: U.S. Environmental Protection Agency, Emissions Trading Policy Statement; General Principles for Creation, Banking, and Use of Emission Reduction Credits, 51 Federal Register 43,814, 43,829 (1986)(final policy statement).

[28]40 C.F.R. 80.20(d)(1988); U.S. Environmental Protection Agency, Control of Lead Additives in Gasoline, 38 Federal Register 33,734 (1973)(final rule).

[29]See: Dudek, Daniel J. and John Palmisano. "Emissions Trading: Why Is This Thoroughbred Hobbled?" Columbia Journal of Environmental Law 13(1988):217-256; and Hahn and Hester, op. cit., 1989.

[30]See: U.S. Environmental Protection Agency. "Costs and Benefits of Reducing Lead in Gasoline." Final Regulatory Impact Analysis VIII-31, 1985.

[31]For an examination of these options, see the Project 88 report; for a more detailed discussion of international trading of greenhouse gas permits and recycling permits, see the Project 88 -- Round II report.

[32]As one example, prior-appropriation water law, the dominant legal instrument for allocating water supplies in the western U.S., is frequently interpreted as implying that the temporary transfer of a water right would indicate a lack of "beneficial use" and would thereby lead to the loss of that water right.

[33]See: Stavins, Robert N. Trading Conservation Investments for Water. Berkeley, California: Environmental Defense Fund, March 1983; and Stavins, Robert N. "Harnessing Market Forces to Protect the Environment." Environment 31(1989), January/February, number 1, pp. 4-7, 28-35.

[34]Morris, Willy. "IID Approves State's First Water Swap with MWD. " Imperial Valley Press, Nov. 9, 1988.

[35]See: Stavins, Robert N. and Adam B. Jaffe. "Unintended Impacts of Public Investments on Private Decisions: The Depletion of Forested Wetlands." American Economic Review 80(1990):337-352; and Stavins, Robert N. "Alternative Renewable Resource Strategies: A Simulation of Optimal Use." Journal of Environmental Economics and Management 19(1990):143-159.

[36]See: Eads, George C. Comments prepared for workshop on "Economics of Sustainable Development," sponsored by the United Nations Economic Commission for Europe and the U.S. Environmental Protection Agency, Washington, D.C., January 25, 1990.

[37]For example, a pollution charge might take the form of a charge per unit of sulfur dioxide emission, not a charge per unit of electricity generated. The choice of whether to tax pollution quantities, activities preceding discharge, inputs to those activities, or actual damages depends upon tradeoffs between costs of abatement, mitigation, damages, and program administration, including monitoring and enforcement.

[38]The OECD distinguishes five types of pollution charges: effluent charges, based upon the quantity of discharges; user charges, which are payments for public treatment facilities; product charges, which are based upon the potential pollution of a product; administrative charges, which are payments for government services such as registration of chemicals; and tax differentiation, which provides more favorable prices for "green"

products. See: Organization for Economic Co-Operation and Development. Economic Instruments for Environmental Protection. Paris: OECD, 1989.

[39]Pollution charges can be applied either to producers to affect their production decisions or to consumers to affect their consumption/disposal behavior. Hereafter, for simplicity, we refer only to firms (and production), although the same concepts apply to consumers.

[40]Any firm, which chose unilaterally to consider such external costs in its production decisions, would be penalized by the market (through reduced cost-competitiveness) for having done so.

[41]For example, a pollution charge might take the form of a charge per unit of sulfur dioxide emissions, not a charge per unit of electricity generated. The choice of whether to tax pollution quantities, activities preceding discharge, inputs to those activities, or actual damages will depend upon tradeoffs between costs of abatement, mitigation, damages, and program administration, including monitoring and enforcement.

[42]One challenge for policy makers is to identify the desirable charge level. If the charge is set too high, production may be curtailed excessively; if the charge is set too low, insufficient environmental protection will result. In general, pollution charges are set with a view towards achieving the overall amount of control desired.

[43]U.S. Congress. The Omnibus Budget Reconciliation Act of 1989 Section 7506: Excise Tax on the Sale of Chemicals Which Deplete the Ozone Layer and of Products Containing Such Chemicals. Washington, D.C.: U.S. Congress. 1989.

[44]United Nations Environmental Programme. Montreal Protocol on Substances that Deplete the Ozone Layer, Final Act. Nairobi: United Nations Environmental Programme, 1987; and United Nations Environmental Programme. Report of the Second Meeting of the Parties to the Montreal Protocol on Substances that Deplete the Ozone Layer. Nairobi: United Nations Environmental Programme. June 29, 1990.

[45]The excise tax is essentially a charge on the sale of permits. See: Harrison Jr., David and Albert L. Nichols. "Tradeable Permits and Other Economic Incentives for Environmental Protection: Final Report." Prepared for the Canadian Electrical Association Workshop on Tradeable Permits. Cambridge, Massachusetts: National Economic Research Associates, June 28, 1990.

[46]Included are the United Kingdom, France, the Netherlands, Sweden, Norway, Denmark, Finland, Italy, and West Germany.

[47]Even those charge mechanisms intended to create pollution-reduction incentives have typically not had such effects, because fee levels were set too low to change producer behavior. See: Organization for Economic Co-operation and Development, op. cit., 1989.

[48]For a description of the charge, see: Brown, Gardner M. Jr. and Ralph W. Johnson. "Pollution Control by Effluent Charges: It Works in the Federal Republic of Germany, Why Not the U.S.?" Natural Resources Journal 24(1984):929-966.

[49]In practice, even this charge is not a fully functioning market incentive, since the fee is linked to uniform performance standards, and as a result, marginal costs of control are not equalized and full cost savings potentials are not realized. See: Harrison, David Jr. and Albert L. Nichols, op. cit., 1990.

[50]See: U.S. Congressional Budget Office. "Energy Use and Emissions of Carbon Dioxide: Federal Spending and Credit Programs and Tax Policies." CBO Working Papers, December 1990.

[51]Paul O'Neill, of the Aluminum Company of America (Alcoa), suggested in the summer of 1990 that energy taxes could accomplish most effectively the dual goals of reducing pollution and reducing the budget deficit. See: Environmental Policy Alert, June 27, 1990, p. 33.

[52]See: Goulder, Lawrence H. "Effects of Carbon Taxes in an Economy with Prior Tax Distortions: An Intertemporal General Equilibrium Analysis for the U.S." Discussion Paper, Stanford University, Stanford, California, June 1991.

[53]See: Terkla, David. "The Efficiency Value of Effluent Tax Revenue." Journal of Environmental Economics and Management 11(1984):107-123.

[54]For further discussion, see: Dower, Roger and Robert Repetto. "Use of the Federal Tax System to Improve the Environment." Testimony to the Long-Term Strategy Hearing on the Environment, U.S. House of Representatives Committee on Ways and Means. Washington, D.C.: World Resources Institute, March 6, 1990.

[55]Studies indicate that, on average, U. S. personal and corporate income taxes generate distortions or pure losses of 20-50 cents for every new dollar of tax revenue collected. See, for example: Ballard, Charles, John Shoven, and John Whalley. "General Equilibrium Computations of the Marginal Welfare Costs of Taxes in the United States." American Economic Review 75(1985):128-138.

[56]See: Houghton, J. T., G. J. Jenkins, and J. J. Ephraums, eds. Climate Change: The IPCC Scientific Assessment. Report Prepared for the Intergovernmental Panel on Climate Change by Working Group I. Cambridge, England: Cambridge University Press, 1990; and Jaeger, Jill.

Developing Policies for Responding to Climate Change. Summary of the discussions and recommendations of the workshops held in Villach (September 28 - October 2, 1987) and Bellagio (November 9-13, 1987) under the auspices of the Bewer Institute, Stockholm. Stockholm, Sweden: World Meteorological Organization and United Nations Environment Programme, 1987.

[57]The first round of negotiations was held in February of 1991, partly in preparation for the U.N. Conference on Environment and Development, to be held in Brazil in June of 1992. For an investigation of how a tradeable-permit system could lead to a cost-effective international agreement, see the Project 88 -- Round II report.

[58]This section of the paper draws, in part, upon: Goulder, Lawrence H. "Using Carbon Charges to Combat Global Climate Change." Paper prepared for Project 88/Round II. August 1990; revised as Stanford University Center for Economic Policy Research Publication No. 226, December 1990.

[59]For an investigation of an international CO_2 charge mechanism, see: Gaskins, Darius. "A Meta Plan: A Policy Response to Global Warming." Working Paper, John F. Kennedy School of Government, Harvard University, Cambridge, Massachusetts, June 1990.

[60]Non-combustible feedstocks should be exempted.

[61]A viable alternative to the carbon charge is a BTU charge, with the tax being based on the energy produced in the burning of the fuel rather than on the fuel's carbon content. If the principal goal is to reduce CO_2 emissions, the carbon charge is theoretically superior, because it targets more effectively the source of emissions, but if the BTU charge is applied only to fossil fuels, the difference in cost-effectiveness between the two is not dramatic. See: Jorgenson, Dale W. and Peter J. Wilcoxen. "The Cost of Controlling U.S. Carbon Dioxide Emissions." Discussion Paper, John F. Kennedy School of Government, Harvard University, Cambridge, Massachusetts, September 1990.

[62]1n contrast to these Congressional Budget Office predictions, EPA estimates that: a $5/ton fee would, by the year 2000, reduce annual domestic carbon dioxide emissions by 1 % to 4 % and raise $7 to $10 billion annually; a $15/ton fee would reduce emissions by 3 % to 12 % and raise $20 to $30 billion per year; and a $25/ton fee would reduce emissions by 8 % to 17% and raise $38 to $50 billion annually. See: U.S. Congressional Budget Office. Carbon Charges as a Response to Global Warming: The Effects of Taxing Fossil Fuels. Washington, D.C., August 1990; and Lashof, Daniel and Dennis Tirpak, eds. Policy Options for Stabilizing Global Climate, Draft Report to Congress. Washington, D.C.: U.S. Environmental Protection Agency, February 1989.

[63]The phased-in $100/ton charge described above would begin with a $10/ton charge in 1991 and rise smoothly to a $100/ton charge in the year 2000 (all figures in 1988 dollars). The models used for short-term projections to the year 2000 are the PCAEO simulation model developed by the Energy Information Administration (EIA) of the U.S. Department of Energy, the Data Resources Incorporated (DRI) quarterly econometric model of the U.S. economy, and the Dynamic General Equilibrium Model (DGEM) developed at Harvard University by Dale Jorgenson and his collaborators.

[64]See: Marine, Alan and Richard Richels. "CO_2 Emission Limits: An Economic Cost Analysis for the USA." The Energy Journal 11(1990), number 2, pp. 51-74. The Manne-

Richels model has been criticized because of its conservative assumptions and failure to provide for endogenous technological change. On this, see: Williams, Robert H. "Low-Cost Strategies for Coping with CO_2 Emission Limits." The Energy Journal 11(1990), number 4, pp. 35-59.

[65]Preliminary studies indicate that the distribution of the burden of a carbon charge would vary regionally by as much as 50%. See: DeWitt, Diane E., Hadi Dowlatabadi, and Raymond J. Kopp. "Who Bears the Burden of Energy Taxes?" Discussion Paper QE91-12, Quality of the Environment Division, Resources for the Future, Washington, D.C., March 1991.

[66]A phased-in $100/ton carbon charge could reduce coal use by 13% annually by the year 2000. See: U.S. Congressional Budget Office, op. cit., 1990.

[67]See, for example: Percy, Charles H. "The Broad Benefits of a Gasoline Tax Hike." New York Times, July 8, 1990.

[68]A number of existing policy proposals are related to -- although distinct from -- a gasoline tax. For example, Project 88 -- Round I recommended increased use of "gas guzzler" taxes and "gas sipper" rebates to help automobile manufacturers to achieve Corporate Average Fuel Economy (CAFE) standards. Similarly, recent legislation would impose taxes on the production of less fuel-efficient automobiles. EPA has considered the use of gas-guzzler fees instead of gasoline taxes, since the former can overcome the observed tendency of consumers to favor products with low initial (and high long-run) costs. Such mechanisms, however, provide no incentives for people to modify their driving habits once they have purchased their cars and trucks. Although gasoline taxes reduce miles driven and -in the long run -- lead to purchase of more fuel-efficient cars, gasoline taxes would be more cost-effective as a pollution-control mechanism if there was also a change from EPA's current system of regulating "grams of pollutants per mile traveled" to a system of regulating "grams of pollutant per gallon of fuel burned." See: Khazzoom, J. Daniel. "The Impact of a Gasoline Tax on Auto Exhaust Emissions." Journal of Policy Analysis and Management 10(1991):434-454.

[69]There are more direct ways of internalizing the "national security externality" associated with imported oil, for example, import levies.

[70]For a description of charge approaches to managing highway congestion, see: Cameron, Michael. Transportation Efficiency: Tackling Southern California's Air Pollution and Congestion. Oakland, California: Environmental Defense Fund and Regional Institute of California, March 1991.

[71]See: Crandall, Robert W. and John D. Graham. "The Effects of Fuel Economy Standards on Automobile Safety." Journal of Law and Economics 32(1989):97-118. Also see: Leigh, J. Paul and James T. Wilkinson. "The Effect of Gasoline Taxes on Highway Fatalities." Journal of Policy Analysis and Management 10(1991):474481.

[72]See: U.S. Environmental Protection Agency. The Solid Waste Dilemma: An Agenda for Action. Municipal Solid Waste Task Force, Office of Solid Waste. Washington, D.C., 1988.

[73]See: Petit, C. I. "Tip Fees Up More Than 30 % in Annual NSWMA Survey." Waste Age, March, 1989, pp. 101-106.

[74]See: "Paper Recycling: For Now, Too Much of a Good Thing." New York Times, September 6, 1989, page A19; and Cutler, Herschel. "Recycling Markets: Is Mandated Recycling Possible?" Solid Waste and Power, volume 54, August 1988.

[75]Unit pricing can lead to efficient (or cost-effective) levels of reliance on alternative waste disposal methods only if prices accurately reflect the real, incremental costs of these alternatives. Many municipalities, however, have underpriced waste disposal services by incomplete cost accounting and use of average rather than marginal-cost pricing. There have also been problems with the cost calculations associated with specific disposal alternatives. For example, landfilling was formerly underpriced, due to weak environmental regulations. See: Savas, E. S. "How Much Do Government Services Really Cost?" Urban Affairs Quarterly 15(1979):23-42.

[76]See: Seattle Solid Waste Utility, Public Information Department. Municipal Solid Waste Management Program Description. Seattle, Washington, 1991. An analysis of a similar program in Tacoma, Washington, indicated that a 10% price increase in collection led to a 2 % reduction in waste disposal. See: Goddard, Haynes C. "Integrated Solid Waste Management: Incentives for Reduced Waste Generation, Increased Recycling and Extension of Landfill Life." Paper presented at the BioCycle National Conference, Minneapolis, Minnesota, May 14, 1990.

[77]See: Bolton, Roger. "Equity in Financing Local Services: The Case of Residential Refuse." Resources and Conservation 11(1984):45-62. Furthermore, the deductibility of local property tax payments from Federal income tax liability is significant in this regard. Given the progressive nature of Federal income taxes, a change from the status quo financing approach (through property taxes) to increased reliance on unit charges will tend to reduce the regressivity of the system.

[78]See: U.S. Environmental Protection Agency. Charging Households for Waste Collection and Disposal: The Effects of Weight or Volume-Based Pricing on Solid Waste Management. Final Report, EPA/530-SW-90-047. Washington, D.C., September 1990.

[79]Such behavior may be constrained by awareness of the fact that the building management could easily identify any untagged bags of trash, which contained material with the owner's name. The inconvenience to consumers of removing all such items from their trash prior to disposal might well convince them to comply with the bag-and-tag system instead.

[80]See: Menell, Peter. "Beyond the Throw-Away Society: An Incentive Approach to Regulating Municipal Solid Waste." Ecology Law Quarterly 17(1990):655-739.

[81]See: Franklin Associates, Ltd. Market for Selected Post-consumer Waste Paper Grades. Draft report submitted to the U.S. Environmental Protection Agency, Washington, D.C., 1990.

[82]A frequently discussed example is newly mined lead. See: Sigman, Hilary. "A Comparison of Public Policies for Lead Recycling." Department of Economics, Massachusetts Institute of Technology, Cambridge, Massachusetts, December 1991.

[83]For a detailed investigation of deposit-refund systems, see: Bohm, Peter. Deposit-Refund Systems: Theory and Applications to Environmental, Conservation, and Consumer Policy. Baltimore, Maryland: Johns Hopkins University Press, 1981.

[84]For further discussion of this point, see: Russell, Clifford S. "Economic Incentives in the Management of Hazardous Wastes." Columbia Journal of Environmental Law 13(1988):257-274.

[85]In 1955, the recovery rate of used motor-vehicle batteries was over 90%; by 1988, it was approximately 75%. Annual fluctuations around this trend, however, have been substantial and are closely linked to prices of virgin and refined lead. See: Putnam, Hayes, and Bartlett, Inc. "The Impacts of Lead Industry Economics on Battery Recycling." Report to the Office of Policy Analysis, U.S. Environmental Protection Agency. Cambridge, Massachusetts, June 1986.

[86]U.S. Environmental Protection Agency. Characterization of Products Containing Lead and Cadmium in Municipal Solid Waste in the United States, 1970-2000. Washington, D.C., January 1989.

[87]Requiring a sales receipt for a refund, however, will remove the incentive for the return of batteries that have already been purchased. Further, given the extended life of most batteries, it may be unrealistic to expect consumers to maintain a receipt for many years.

[88]This complication may not be severe since the testing of individual solvent shipments is already standard practice at many recycling facilities.

[89]See: Temple, Barker, and Sloane, Inc. "1988 Used Oil Flows in the U.S." Report to the U.S. Environmental Protection Agency, Washington, D.C., 1989.

[90]For an examination of deposit-refund systems and other incentive-based policy mechanisms for used lubricating oil, see: Anderson, Robert C., Lisa A. Hofmann, and Michael Rusin. The Use of Economic Incentive Mechanisms in Environmental Management. Research Paper #051. Washington, D.C.: American Petroleum Institute, June 1990.

[91]See: U.S. Environmental Protection Agency. Economic Incentives: Options for Environmental Protection, op. cit., March 1991.

[92]This and the following mechanisms, intended to increase the overall efficiency of urban transportation systems, are described in detail by: Cameron, Michael. Transportation Efficiency: Tackling Southern California's Air Pollution and Congestion." Oakland, California: The Environmental Defense Fund and the Regional Institute of Southern California, March 1991.

[93]For a description of the incentives faced by forest managers, see: O'Toole, Randal. Reforming the Forest Service. Washington, D.C.: Island Press, 1988. For a description of market-based mechanisms to improve resource management, see Project 88 -- Round II.

[94]For example, the Pittman Robertson Federal Aid in Wildlife Restoration Act of 1937 levies an 11 % manufacturers excise tax on sporting rifles, shotguns, ammunition, handguns, and archery equipment. Similarly, the 1951 Dingell-Johnson Federal Aid in Sport Fishing Restoration Act levies a 10% manufacturers excise tax on sport fishing equipment.

[a] This can be offset to some degree by expanded production that results from lower total operating costs.

[b]This assumes that permits are distributed free of charge to firms, not auctioned by the government. In the latter case, permits and charges are quite similar in terms of these financial transfers.

[c]Although no magic cut-off point exists, it is unlikely that firms could engage in price-setting behavior if they controlled less than 10% of the market. See: Scherer, F.M. Industrial Market Structure and Economic Performance. Chicago: Rand McNally College Publishing Company, 1980. Ultimately, the question is whether other firms present credible threats of entry to the market i.e., whether the market is "contestable." If so, it is less likely that anti-competitive behavior can thrive. See: Baumol, William J., John Panzer, and Robert Willig. Contestable Markets and the Theory of Industrial Structure. New York: Harcourt Brace Jovanovich, 1982.