PROJECT 88 - ROUND II

INCENTIVES FOR ACTION: DESIGNING MARKET-BASED ENVIRONMENTAL STRATEGIES

CHAPTER 1
ENVIRONMENTAL POLICY FOR THE 1990'S

In many ways, Earth Day 1970 signaled the beginning of the modern era of environmentalism. By Earth Day 1990, the United States and other nations had enacted a host of environmental laws and regulations, and had made substantial gains in environmental protection. In some spheres, the environment *is* cleaner today than it was before. But significant domestic and global environmental challenges remain -- both ongoing problems, such as solid and hazardous waste management, and newly recognized problems, including the threat of global climate change. At the same time, the costs of environmental protection continue to increase. We now spend over $100 billion annually in the U.S. to comply with Federal environmental laws and regulations.[1]

As we enter the 1990's, political leaders are giving greater attention to a promising set of new environmental policies which recognize market forces, not only as part of the problem, but also as a potential part of the solution. An opportunity now exists to enter a new era of enlightened environmental policy by mobilizing market forces to complement traditional regulatory strategies. An outline for such a dramatic new thrust in environmental policy was provided two years ago in this report's predecessor, *Project 88: Harnessing Market Forces to Protect Our Environment.*[2] That report 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.

Over the past two years, the nature and tone of political debate on environmental issues has evolved rapidly, as illustrated by the enactment, late in 1990, of a major overhaul of the Clean Air Act to include a market-oriented approach to controlling acid rain. Many factors contributed to this rapid evolution of policy prescriptions, including strong interest within the Executive Office of the President; aggressive participation

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[1]See: U.S. Environmental Protection Agency. *Environmental Investments: The Cost 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%).

[2]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.

by some segments of the environmental community;[3] and bipartisan support in the Congress, including the release, in December 1988, of the first Project 88 report.[4]

There is a growing consensus in the policy community that market-oriented or incentive-based[5] approaches should be considered as part of our overall portfolio of environmental-protection strategies. If Round I of Project 88 helped to introduce these "good ideas" into policy deliberations, the question which must now be addressed is whether these are indeed "good ideas that work." We must move from general concepts to the design of *effective and practical* incentive-based policy mechanisms for improved environmental protection and natural resource management. As part of the effort, this report focuses on design issues associated with incentive-based policies for three problem areas of particular importance: global climate change due to the greenhouse effect; generation and disposal of solid and hazardous waste; and management of natural resources.

THE CHANGING POLITICAL LANDSCAPE OF ENVIRONMENTAL POLICY

Environmental quality has been a pressing issue on the American agenda for at least two decades,[6] but has attracted unprecedented attention in the last two years. Private industry has responded to this burgeoning interest in environmental affairs,[7] which has included substantial attention to incentive-based policy approaches.[8] In the past, economic-incentive approaches were often characterized as "licenses to pollute" or dismissed as completely impractical. President Lyndon Johnson's proposal for effluent fees was never given serious consideration, nor were President Richard Nixon's recommendations for a tax on lead in

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[3]When introducing his Clean Air proposals at the White House on June 12, 1989, President Bush said: "Let me commend Project 88 and groups like the Environmental Defense Fund for bringing creative solutions to long-standing problems, for not only breaking the mold, but helping to build a new one."

[4]Several other studies followed the Project 88 report, including: Moore, John L., *et. al. Using Incentives for Environmental Protection: An Overview*. Washington, D.C.: Congressional Research Service, June 1989; and Anderson, Robert C., Lisa A. Hofmann, and Michael Rusin. *The Use of Economic Incentive Mechanisms in Environmental Management*. Washington, D.C.: American Petroleum Institute, June 1990.

[5]These policies are described within the policy community as "economic incentive approaches," "market-based," "market-oriented," or "incentive-based." In any case, both (positive) incentives and disincentives are included.

[6]See: Ladd, E. C. "Clearing the Air: Public Opinion and Public Policy on the Environment." *Public Opinion*, February/March 1982, pp. 16-20.

[7]See: Main, Jeremy. "Here Comes the Big New Cleanup." *Fortune*, November 21, 1988, pp. 102-118; Smith, Emily T. and Vicki Cahan. "The Greening of Corporate America." *Business Week*, April 23, 1990, pp. 96-103; and Jacobs, Deborah L. "Business Takes on a Green Hue." *New York Times*, September 2, 1990, p. 25.

[8]See: Passell, Peter. "Private Incentives As Pollution Curb." *New York Times*, October 19, 1988, p. D2; "The Greening of the Invisible Hand." *The Economist*, December 24, 1988, p. 107; Cairncross, Frances. "Costing the Earth." *The Economist*, September 2, 1989, pp. 1-18; and Morgenson, Gretchen and Gale Eisenstodt. "Market-Driven Environmentalism." *Forbes*, March 5, 1990, pp. 94-100.

gasoline and a sulfur-dioxide emission fee. Now, however, economic-incentive policies for enhancing environmental quality have moved to center stage in Washington and a number of state capitals.[9]

Actual policy mechanisms for specific environmental problems are now being examined within the Administration and in Congress. The Administrator of the U.S. Environmental Protection Agency (EPA), William K. Reilly, partly in response to the first Project 88 report, established an Economic Incentives Task Force to investigate the potential application of market-oriented policies throughout EPA's jurisdiction.[10] More dramatically, the tradeable-permit system for acid-rain control, which was recommended by Project 88, was adopted by the Administration,[11] and then included in the Clean Air amendments approved in 1990 by the Congress. In addition, the Congress is considering bills that would apply economic-incentive mechanisms to problems as diverse as water pollution and hazardous waste management,[12] and the Administration has examined incentive-based policies to address the threat of global climate change.[13] In Canada, active interest in market-oriented approaches to environmental protection has also increased dramatically over the past two years, at both the national and provincial levels.[14]

In the United Kingdom, the Thatcher government embraced a study recommending increased reliance on economic-incentive mechanisms for a variety of resource and environmental problems.[15] Major incentive-based programs have been initiated in Belgium and Italy, and the approach is gaining ground elsewhere in Europe, as well. Perhaps most striking, as massive political and economic changes have gripped the Soviet Union and Eastern Europe, several of these nations have expressed interest in market-oriented environmental policies. Within the Soviet Union, the Central Institute of Mathematics and Economics of the Academy of Sciences has advocated the use of pollution taxes, while Polish and Czechoslovakian government officials have endorsed a variety of market-oriented approaches to air and water pollution problems.

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[9]For an analysis of why these changes have occurred, see: Hahn, Robert W. and Robert N. Stavins. "Market-Based Environmental Regulation: A New Era From An Old Idea?" *Ecology Law Quarterly*, volume 18, number 1, forthcoming 1991.

[10]See: U.S. Environmental Protection Agency. *Economic Incentives: Options for Environmental Protection*. Office of Policy, Planning, and Evaluation, Economic Incentives Task Force, 21P-2001. Washington, D.C., March 1991.

[11]On June 12, 1989, President Bush announced the tradeable-permit system for acid-rain control as part of the Administration's Clean Air Act amendments. This proposal was sent to Congress on July 21, 1989.

[12]More than 100 bills characterized by EPA as using economic incentives were introduced in the 101st Congress. See: U.S. Environmental Protection Agency. *Economic Incentives in Pending Environmental Legislation*. Office of Policy, Planning, and Evaluation. Washington, D.C., July 1990.

[13]Although the Administration has maintained that it is still too soon to establish greenhouse goals and standards, it has also suggested that when and if such standards or goals are established, consideration should be given to cost-effective, market-based policy instruments. See Chapter 2 of this study.

[14]See, for example: Nichols, Albert L. and David Harrison, Jr. *Using Emissions Trading to Reduce Ground-Level Ozone in Canada: A Feasibility Analysis*. Final Report Prepared for Environment Canada. Cambridge, Massachusetts: National Economic Research Associates, Inc., November 1990.

[15]See: Pearce, David, Anil Markandya, and Edward B. Barbier. *Blueprint for a Green Economy*. London: Earthscan Publications, 1989.

Within the U.S., these changes in the political landscape of environmental policy represent a significant departure from long-term trends. Only a few years ago, serious consideration of market-oriented environmental-protection policies was restricted to economists and others at research institutions.[16] But late in the 1980's, a new breed of environmentalism emerged that began to embrace these innovative approaches,[17] which are now winning support among major environmental advocacy groups.[18]

MARKET-BASED ENVIRONMENTAL POLICIES: WHAT THEY ARE AND HOW THEY WORK

Why all this emphasis on market forces, in the first place? The answer is purely practical. Selective and careful use of economic incentives can enable us to achieve greater levels of environmental protection at lower overall cost to society. A central principle is that as consumers and as producers, each and every one of us needs to weigh the full social costs and consequences of our decisions before acting. This principle applies, for example, to our decisions as consumers to use products such as lead-acid batteries and to dispose of them at municipal landfills, where the lead can eventually contaminate ground water aquifers. It also applies to producers' decisions to generate electricity in ways that may inject sulfur dioxide into the atmosphere, causing acid rain at downwind locations.

Market-based environmental policy mechanisms provide various ways to make consumers and producers recognize these social costs and consequences, and thus provide incentives for environmental protection. The creativity and power of the market -- the awesome strength of millions of decentralized decision-makers -- can be deployed on behalf of environmental protection, instead of against it. Incentive-based approaches can also encourage firms to develop and implement more effective and efficient pollution-control technologies and strategies.

Incentive-based mechanisms are not appropriate for all environmental and resource problems, however.[19] To identify appropriate applications, we need to understand both the merits and the limitations of these market-oriented policy mechanisms. By way of background, it is useful to review the approach most

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[16]Legal scholars and practicing attorneys have been among the most eloquent supporters of these strategies. See, for example: Stewart, Richard B. "Controlling Environmental Risks Through Economic Incentives." *Columbia Journal of Environmental Law* 13(1988):153-169; Krier, James E. "Marketlike Approaches: Their Past, Present, and Probable Future." LeRoy Graymer and Frederick Thompson, eds., *Reforming Social Regulation*, pp. 151-158. Beverly Hills: Sage Publications, 1982; and Levin, Michael H. "New Directions in Environmental Policy: The Case for Environmental Incentives." *Proceedings of Annual Midwinter Meeting, American Bar Association, Section of Natural Resource Law*. Keystone, Colorado, March 18-20, 1988.

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

[18]The Environmental Defense Fund, the Wilderness Society, the National Audubon Society, the National Wildlife Federation, the Sierra Club, the Natural Resources Defense Council, and the Conservation Law Foundation have all come to support *selective* use of economic-incentive mechanisms.

[19]Also, most incentive-based policy mechanisms actually rely upon an underlying conventional regulatory structure, a point that will be illustrated throughout this study.

often applied to environmental regulation in the United States and other countries: command-and-control.[20] Pollution-control problems provide good examples.

Conventional Command-and-Control Regulatory Mechanisms

With conventional approaches to pollution control, the government either specifies the technology that must be used for this purpose (a technology-based standard)[21] or sets an emission-rate cap that all sources must meet (a uniform performance standard). In the first case, government in effect specifies the equipment that must be used to control pollution. An electrical utility, for example, may (in effect) be required to install flue-gas scrubbers to control sulfur dioxide emissions or electrostatic precipitators to control particulate matter. Greater flexibility is provided by performance standards, which allow firms to decide how they will meet the specified goal (for example, a maximum allowable level of pollutant emitted per unit of product output).

These conventional policy approaches can be effective in achieving environmental goals, but they tend to impose relatively high costs on society, because some unnecessarily expensive means of controlling pollution will be used. The costs of controlling emissions vary greatly from one source to another. For certain pollutants, the cost per unit controlled may vary by a factor of 100 or more,[22] depending upon the age and location of plants and the technologies at their disposal. To control total pollution to a given level at the lowest possible cost, all firms must control at the same incremental or marginal cost (as opposed to the same emission or control level). Otherwise, the same aggregate level of pollution abatement could be achieved at lower total cost by increasing the control exercised by low-cost controllers and decreasing control by high-cost controllers.

To achieve a cost-effective allocation of the pollution-control burden, the government could force all sources to control at the same marginal control cost. This would ensure that low-cost controllers control more, and high-cost controllers control less. But the government would need detailed information about the costs faced by each individual source, which could be obtained only at very great cost, if at all. Fortunately there is a way out of this impasse. Economic-incentive systems lead firms to undertake pollution-control efforts that allocate the control burden appropriately. By making it costly for firms to increase their pollution, the government encourages them to clean up in a cost-effective manner: the invisible hand of the market is brought to bear on behalf of the environment. Incentive-based approaches fall into five major categories: pollution charges; tradeable permits; deposit-refund systems; market-barrier reductions; and government-subsidy elimination.

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[20]This part of the chapter draws, in part, on: Stavins, Robert N. "Innovative Policies for Sustainable Development: The Role of Economic Incentives for Environmental Protection." *Harvard Public Policy Review*, volume 7, number 1, pp. 13-25, Spring 1990; and Hahn and Stavins, *op. cit.*

[21]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.

[22]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.

Pollution Charges

Producers of pollution may be charged a fee or tax on the amount of pollution they generate (not simply on their pollution-generating activities).[23] It will then be worth their while to reduce pollution up to the point at which their (marginal) cost of control is equal to the pollution-tax rate. 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 minimizes the aggregate costs of pollution control and gives firms ongoing incentives to develop and adopt newer and better pollution-control technologies.

An effective pollution charge system can impose a significant monitoring burden on government, however. Also, it is difficult to estimate in advance how large a charge will be required to obtain a desired level of pollution reduction, and it may be difficult -- in a political context -- to establish charges large enough to achieve given environmental objectives.

Although air and water pollution charges have been adopted in France, the Netherlands, Sweden, Norway, Denmark, Finland, Italy, and West Germany,[24] these charge schemes have been designed primarily as revenue-raising devices, rather than as serious incentive-based environmental policy instruments.[25] Several European nations remain interested in imposing further "green taxes." This study investigates various policy mechanisms that apply the pollution-charge concept, including a CO_2 (carbon or BTU) charge to help combat global climate change; "environmental costing" at electrical utilities; and unit charges for pickup and disposal of municipal solid waste.

Tradeable Permit Systems

Unlike a charge system, a system of tradeable permits allows the government to specify an overall level of pollution that will be tolerated. This total quantity is allotted in the form of permits among polluters (firms). Firms that keep their emission levels below the allotted level may sell or lease their surplus allotments to other firms, or use them to offset excess emissions in other parts of their own facilities. Such a system will tend to minimize the total societal cost of achieving a given level of pollution control.[26] It is important to note

[23]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.

[24]Opschoor, J. B. and Hans B. Vos. *Economic Instruments for Environmental Protection*. Paris: Organization for Economic Cooperation and Development, 1989.

[25]Whatever their motivation, properly designed pollution charges will have the effect of discouraging fundamentally undesirable activities (pollution), whereas conventional taxes tend to discourage fundamentally desirable activities, namely labor and the generation of capital.

[26]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.

that both charges and permit systems can be used to improve environmental quality, not just to maintain the status quo.

A disadvantage of tradeable permit systems is that the total cost of control is not known in advance. Also, if the number of regulated sources of emissions is great, the administrative (transaction) costs of these systems can be very high. On the other hand, if very few sources are involved, problems of concentration in the permit and product markets may arise, with consequent inefficiencies introduced by noncompetitive behavior.[27] Finally, regulators must decide how to allocate permits among sources: should they be given away as an endowment, or should they be sold through an auction? If they are distributed free of charge, what criteria should be used in the allocation?

Tradeable permit mechanisms have been applied primarily in the U.S., under EPA's Emissions Trading Program,[28] the nationwide phasedown of lead in automotive fuel,[29] and chlorofluorocarbon (CFC) reduction. As mentioned above, Congress has enacted a tradeable-permit system for acid-rain control. Other potential areas of application include: local, "criteria" air-pollution control; point- and nonpoint-source water-pollution control; control of global climate change through international trading in greenhouse gas permits;[30] and recycling credits, whereby recycling targets are combined with tradeable permits. The last two mechanisms are investigated in Chapters 2 and 3, respectively, of this study.

Deposit-Refund Systems

Nine states of the U.S., several Canadian provinces, and a number of European nations have enacted "bottle bills" to reduce littering with beverage containers. In effect, purchasers of potentially polluting products pay a surcharge, which is refunded to them when they return the product to an approved center for recycling or proper disposal. Such deposit-refund systems could be used for containerizable hazardous waste and for some other forms of solid waste, as we discuss in Chapter 3. Lead-acid batteries, motor vehicle oil, and industrial solvents are potential candidates. Rhode Island and Maine have enacted deposit-refund systems for automobile batteries, and Maine has a system for commercial-size pesticide containers. Denmark has

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[27]These and other concerns are discussed in detail in Chapter 3 in the context of our investigation of a specific tradeable permit program, recycling credits.

[28]Firms have generally not made extensive use of the components of the Emissions Trading Program -- bubbles, offsets, netting, and banking -- partly because states are not required to use them, and partly because of uncertainties about the future course of the programs. Nevertheless, companies such as Armco, Du Pont, USX, and 3M have traded emissions credits; even this limited degree of trading has resulted in more than $4 billion in savings in control costs, with no adverse effect on air quality. See: Dudek, Daniel J., and John Palmisano. "Emissions Trading: Why Is This Thoroughbred Hobbled?" *Columbia Journal of Environmental Law* 13(1988):217-256; and Liroff, Richard A. *Reforming Air Pollution Regulations: The Toil and Trouble of EPA's Bubble*. Washington, D.C.: The Conservation Foundation, 1986.

[29]From 1982 through 1987, during EPA's phasedown of the leaded content of gasoline, refiners could create credits by producing gasoline with a lower lead content than required by law. Savings due to the lead trading program were about $200 million annually. See: U.S. Environmental Protection Agency. *Costs and Benefits of Reducing Lead in Gasoline, Final Regulatory Impact Analysis*. Washington, D.C., February, 1985. The Netherlands accomplished its own leaded-gasoline phasedown (over a period of two years) through a tax differential of 8¢/gallon.

[30]All of these options were examined in the Project 88/Round I report.

such a plan for mercury and cadmium batteries, and Norway and Sweden have implemented deposit-refund systems for car bodies.

Removing Government Barriers to Market Activity

In some cases, environmental protection can be improved simply by 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. We examine this policy approach in detail in Chapter 4. Similarly, comprehensive least-cost bidding at electrical utilities would promote economically rational energy generation and consumption. This option is examined in Chapter 2, in the context of policies to combat global climate change.

Eliminating Government Subsidies

Many government subsidies promote economically inefficient and environmentally unsound development. A major example is the U.S. Forest Service's "below-cost timber sales," which recover less than the cost of making timber available. The result has been inefficient timber cutting on government lands, which has led to substantial losses of habitat and damages to watersheds. We consider alternative means of eliminating these below-cost timber sales in Chapter 4. Other examples of programs that may be both economically inefficient and environmentally disruptive include certain U.S. Army Corps of Engineers flood-control projects[31] and certain U.S. Bureau of Reclamation projects.

Comparing Market-Based Approaches with Conventional Policies

In many cases economic-incentive approaches will allow a given level of environmental protection to be achieved at lower total cost than would be possible with conventional policy approaches. Rather than set rigid technology-based standards, incentive-based systems impose a cost on pollution-causing activities, allowing individual firms to decide how they will achieve the required level of environmental protection. In a competitive market economy, market forces will then tend to drive these decisions toward least-cost solutions. The resulting savings in production costs and consequent increases in productivity are especially valuable at a time of substantial concern regarding the United States' international competitiveness. It has been estimated, for example, that the market-based approach to acid-rain reduction could save $1 billion per year over a dictated technological solution.[32]

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[31]See Chapter 6 of Round I of Project 88. Also, 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.

[32]ICF Resources, Inc. *Analysis of Six and Eight Million Ton 30-Year/NSPS and 30-Year/1.2 Pound Sulfur Dioxide Emission Reduction Cases*. Washington, D.C., February 1986.

Incentive-based policies can also stimulate the private sector to develop new pollution-control technologies and expertise. Because investments in pollution control can improve firms' profits under incentive-based systems, firms will be encouraged to adopt superior pollution-control technologies, which in turn creates incentives for research and development of cheaper and better pollution-abatement techniques. Incentive-based approaches have the additional benefit of making the environmental debate more understandable to the general public. Attention can focus directly on what our environmental goals should be, rather than on difficult technical questions concerning alternative means of reaching those goals. Also, incentive-based approaches need not be any more expensive for the government to administer than conventional methods. But no program of controls can be effective without a government commitment to monitoring and enforcement, and that will inevitably mean significant government expenditures.

In any event, market-oriented policies will certainly not fit every problem. Whereas incentive-based approaches seem virtually tailor-made for problems of aggregate pollution levels over a large area (for example, acid rain), some environmental problems involve highly localized effects and threshold damages. In such cases, concern focuses on the level of pollution emitted by individual sources, and a command-and-control approach, such as a source-specific emission limit, may represent the preferred policy.

In some situations, moreover, practical problems may make it impossible to implement incentive-based environmental policies successfully, even if they are appropriate on theoretical grounds. Such implementation problems can render even the best policy idea quite useless. To design improved policies, it will be necessary to adapt, not abandon, present programs and build step-by-step on previous initiatives with market-based methods.

DESIGNING MARKET-BASED ENVIRONMENTAL POLICIES

The original Project 88 report provided a comprehensive examination of thirteen environmental and natural resource problems facing the U.S.,[33] and recommended thirty-six policies for dealing with those problems. Because of the scope of that effort, the policy recommendations were necessarily broad and conceptual; relatively little attention was given to specifics of program design. The current study helps fill this gap by focusing on a much smaller set of problem areas and providing more intensive analyses of policy design issues.

Throughout the study, we ask whether the policy mechanisms being investigated will result in real improvements over existing or alternative policies. In particular, we keep in mind the following criteria for improved environmental and resource policy:[34]

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[33]The thirteen problem areas were: the greenhouse effect and climate change; stratospheric ozone depletion; local air pollution; acid rain; indoor radon pollution; threats to energy security and environmental quality; inefficient use and allocation of water supplies; degradation of surface and ground water supplies; management of public lands; depletion of wetland resources; solid waste management; presence of toxic substances in the environment; and management of toxic and infectious waste.

[34]See: Bohm, Peter and Clifford S. Russell. "Comparative Analysis of Alternative Policy Instruments." *Handbook of Natural Resource and Energy Economics, Volume I*, eds. Allen V. Kneese and James L. Sweeney, pp. 395-460. Amsterdam: North-Holland, 1985.

- Will the policy achieve our environmental goals?
- Will the policy approach be cost-effective? That is, will it achieve environmental goals at least cost to society at large?
- Will the strategy provide government agencies and private decision makers with needed information?
- Will monitoring and enforcement costs be reasonable?
- Will the policy be flexible in the face of changes in tastes, technology, or resource use?
- Will the policy give industry incentives to develop new environment-saving technologies, or will it encourage firms to retain existing inefficient plants?
- Will the effects of the policy be equitably distributed, and will any inequities be resolvable through government action?
- Will the purpose and nature of the policy be broadly understandable to the general public?
- Will the policy be truly feasible, in terms of both enactment by the Congress and implementation by the appropriate departments or agencies?

As we enter the 1990's, three environmental issues stand out, because of their magnitude and timeliness, and the applicability of incentive-based approaches. Specific policy mechanisms to address these major problem areas -- global climate change due to the greenhouse effect; the generation, storage, and disposal of hazardous and solid waste; and management of natural resources -- are investigated in Chapters 2, 3, and 4, respectively. The following sections of this chapter provide a very brief overview of the policy mechanisms we investigate.

Global Climate Change

The possibility of global climate change due to the greenhouse effect is potentially one of the most important -- and certainly one of the most controversial -- environmental threats we currently face. Scientific evidence suggests that global mean temperatures may increase by 2 to 5 degrees Fahrenheit in the next century, because of increasing atmospheric concentrations of carbon dioxide and other gases. Given the high degree of uncertainty still prevailing within the scientific community, this report makes no attempt to draw conclusions regarding the likely magnitude of damages induced by global warming or the level of appropriate controls (if any). Instead, we focus on the policy questions that will have to be faced should various levels of government decide that action is warranted. Three policy proposals are offered:

- *International trading among nations in greenhouse gas source/sink permits* should be part of any effort to allocate greenhouse targets among nations. Such a mechanism can simultaneously address issues of cost-effectiveness and equity.

- *Revenue-neutral CO_2 (carbon or BTU) charges* can be a practical mechanism for reaching domestic emissions targets that arise from international negotiations. Such charges would cost less than most alternative measures, and their potential effects on competitiveness could be mitigated through reductions in distortionary taxes.

- *Comprehensive least-cost utility bidding and planning* can be used, even in the absence of international agreements, to increase efficiency of electricity generation and use, and thus reduce CO_2 emissions. Auctions for new power sources would incorporate environmental impacts into cost estimates and would allow for bids based upon demand-side reductions through conservation.

Solid and Hazardous Waste Management

Solid and hazardous waste problems have become ubiquitous throughout the United States and much of the industrialized world. The issues are diverse. For some wastes, space is the principal issue, as old landfills close and it becomes increasingly difficult to find sites for new landfills or incinerators. For other wastes, the problem is one of improper disposal, with effects ranging from the aesthetic consequences of litter to potential health and ecological damages from toxic materials. Since waste management represents a broad range of challenges rather than a single policy problem, and since disposal economics can vary dramatically across geographic areas, a portfolio of policies tailored to local conditions is required. While the Federal government may play an important role in promoting certain actions, much of the activity must occur at the municipal and state levels. Several market-based policies should be included in the regulator's tool kit:

- *Unit pricing of municipal solid waste collection and disposal* ought to be considered the first line of attack. Much of the municipal solid waste problem arises because consumers and producers fail to recognize the real costs of the wastes they generate. Better price signals can reflect the real incremental costs of waste generation and disposal. Local conditions will determine which instrument is most appropriate.

- *Retail disposal charges* may supplement or substitute for unit pricing in situations where unit pricing is impractical or where certain products have especially high disposal costs relative to their volume.

- *Virgin materials charges*, which can incorporate material disposal costs into product economics, can also help to reduce the flow of municipal wastes.

- *Recycling credits -- recycling targets combined with tradeable permits* -- can be a cost-effective means for achieving recycling-content goals.

- *Deposit-refund systems* can be an attractive option for wastes that pose health, ecological, or aesthetic effects when improperly disposed of.

- *Local binding referenda linked with negotiated mitigation packages* can help ease the NIMBY ("not in my backyard") problem (which plagues the siting of new facilities) by reducing incentives for intransigence and more accurately addressing concerns of local citizens.

Natural Resource Management

The management of our endowment of natural resources remains one of the most contentious areas of environmental concern. Our use of water supplies is hotly debated, particularly in the West, where supplies are especially scarce. Great concern also focuses on the management of other public lands and resources. Economically inefficient, heavily subsidized timber cutting on public lands, for example, has led to loss of habitat, damage to watersheds, and a diminution of recreational opportunities. To address these resource management concerns, this report proposes that:

- *Water markets for voluntary exchanges* should be facilitated by Federal and state agencies to improve economic efficiency and create incentives for greater conservation and environmental protection.

- *Below-cost timber sales on national forests should be eliminated* by decentralizing forest management, incorporating the economic values of *all* forest uses, and improving payment mechanisms to localities.

THE IMPORTANCE OF EQUITY CONSIDERATIONS

Throughout this study and the original Project 88 report, we focus attention on policies that will achieve environmental goals at least overall cost to society. But efficiency (or cost-effectiveness) constitutes only one of several criteria that need to be considered when evaluating public policies. A particularly prominent concern is fairness or equity.

Market-oriented environmental policies bring some good news and some bad news. The good news is that environmental goals can be achieved at lower (often much lower) total cost to society than with conventional command-and-control approaches. Thus, society as a whole is better off than it would otherwise be. The bad news is that some individuals may be worse off. In other words, while the aggregate benefits of a policy may greatly exceed its aggregate costs, some individuals or firms may bear costs that are higher than the benefits they receive. This liability, however, is common to all policies, conventional or market-based.

The tension between efficiency and equity is brought into focus, although not created, by market mechanisms. Because of the important ethical concerns surrounding these issues and because of their great importance in the real world of environmental politics, these tradeoffs cannot be ignored. We must ask ourselves whether and under what circumstances we should modify our proposals for cost-effective reforms to mitigate outcomes perceived to be inequitable. If such adjustments are called for, what form should they take?

A pragmatic approach, which merits consideration in the context of specific policies, is to include equity-enhancing measures in policies chosen because they are cost-effective. Where merited, such efforts should be linked to the nature of the harm done. That is, if jobs are lost as a result of a policy change, it is preferable to provide compensation in the form of new job opportunities, as opposed to simple monetary payments. Inevitably, the strength of the case for some form of compensation or mitigation depends on the specific policy approach and problem being considered. General rules are of little use; instead, each specific

policy mechanism must be investigated within its setting to determine whether the overall policy package should include provision for adjustment, mitigation, or compensation.

PROGNOSIS FOR CHANGE: AN ENVIRONMENTAL AGENDA FOR THE 1990'S

Governments, corporations, and individuals around the world have never paid more attention to environmental and natural resource issues than they do today. During the past two years they have focused increasingly on a new breed of policies intended to harness market forces to protect the environment. Round I of Project 88 helped to introduce such ideas into high-level policy deliberations. The question we face now is how to transform these good ideas into policies that work. As we move from general concepts to the design of effective and practical market-based environmental strategies, we seek policies that are not only technically sound, but also politically realistic.

Creative thinking can allow us to design effective, efficient, equitable, and truly feasible policies and programs. The first Project 88 report emphasized that selective use of incentive-based policies could enable us to achieve greater levels of environmental protection at lower overall cost to society, but that market-based policies were not necessarily appropriate for all problem areas. Project 88/Round II reinforces that message: no single policy approach -- whether market-based or command-and-control -- can be a panacea for the diverse environmental and natural resource problems we face. The real challenge is to choose the right policy for each job.

The political landscape of environmental policy has changed dramatically over the past two years, as environmentalists, legislators, bureaucrats, business persons, and citizens have begun to recognize that market-based approaches belong in our portfolio of environmental and natural resource policies. So far, however, we have taken only the first steps toward improved environmental policy. The steps that remain will be not only more important, but also more difficult. The real work of detailed design and implementation lies ahead. We now have an opportunity -- created by a receptive mood at the Federal and state levels and internationally -- to take up this challenge and begin to make real progress.

CHAPTER 2
GLOBAL CLIMATE CHANGE

Of the many environmental problems which have arisen since the beginning of the industrial revolution, few have posed greater risks or greater uncertainties that the threat of global climate change due to the greenhouse effect. Trace gases such as carbon dioxide (CO_2), methane, nitrous oxide, and chlorofluorocarbons (CFCs) transmit much of the sun's visible radiation, which warms the earth's surface, but these same gases absorb much more of the planet's infrared radiation, thus preventing the escape of planetary-generated heat into space. Burning of fuels -- particularly of fossil fuels -- has increased the concentration of CO_2 in the atmosphere since the industrial revolution. Indeed, many scientists are concerned that if emissions of CO_2 and other greenhouse gases continue to increase at current rates, global mean temperatures may increase by 2 to 5 degrees Fahrenheit in the next century, which could cause widespread

changes in precipitation patterns, storm frequencies and intensities, and ocean levels.[35] Specific local, regional, and national impacts remain undetermined and extremely difficult to predict.

This chapter begins with a brief overview of the suspected causes and anticipated consequences of global climate change. Recognizing that substantial scientific uncertainty exists with respect to the timing and location of potential impacts, the report makes no attempt to draw conclusions regarding the likely magnitude of damages caused by global climate change. Rather, it proceeds to address a set of important policy questions which will have to be faced should various levels of government decide that action is warranted. First, if international agreements allocate greenhouse standards or targets among nations, how might this be carried out in a cost-effective manner, i.e. in such a way that the aggregate costs of achieving overall targets are minimized? We investigate a promising mechanism, international trading in greenhouse gas source/sink permits. Second, if an international agreement sets targets for individual nations (as the Montreal Protocol provided CFC targets), how could the U.S. achieve its goal at minimum cost? Here, we investigate carbon charges, BTU charges, and related policies. We focus on a politically appealing approach, revenue-neutral charge systems.

Assuming that an international agreement will be reached (the first round of negotiations were held in February, 1991), we investigate those two policy mechanisms -- international permit trading as a means of cost-effectively reallocating the greenhouse control burden among nations, and charge systems as a cost-effective means of achieving domestic greenhouse targets -- as following international action. An additional question naturally arises: are there any greenhouse policies which the U.S. could reasonably adopt on a unilateral basis, without waiting for an international agreement on greenhouse gas emissions? The answer is yes: certain policies to encourage increased energy efficiency can have positive net benefits, regardless of their implications for global climate change. We examine one important, cost-effective incentive for increased energy efficiency: comprehensive, environmental least-cost utility planning and bidding.

CAUSES, CONSEQUENCES, AND CURRENT POLICIES

The greenhouse effect -- the trapping of some of the sun's heat within our planet's atmosphere -- is necessary for life on earth. As a result of human activities, however, concentrations of certain gases have been increasing, augmenting the greenhouse effect and thereby raising the possibility of climate changes across the globe. Despite near universal scientific agreement about the theory behind the greenhouse effect, there remains substantial uncertainty regarding the rate, magnitude, timing, and regional implications of future climate changes caused by human activities. It is well within the realm of possibility, however, that climate changes will be large enough to engender significant social, environmental, and economic costs.

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[35]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.

Causes of Global Climate Change

Carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), and chlorofluorocarbons (CFCs) are the primary greenhouse gases. CO_2 is the most common of these gases, increasing in the atmosphere by 0.5% per year; at present, it is believed to account for over 60% of current contributions to warming (Table 2-1). The major anthropogenic (man-made) source of atmospheric CO_2 has been fossil-fuel combustion, accounting for 98% of all industrial CO_2 emissions.[36] CFCs constitute another important set of greenhouse gases and a link between climate change and stratospheric ozone depletion. Despite their lower atmospheric concentrations, CFCs are important because they are very effective absorbers of infrared radiation. Lastly, methane and nitrous oxide collectively account for roughly 20% of current contributions to greenhouse-induced warming.

It is very difficult to predict the future path of greenhouse-gas emissions. The long time frames

Table 2-1: Contribution of Trace Gases to the Greenhouse Effect

Trace Gas	Relative Cumulative Contribution to Greenhouse Effect of 1990 Anthropogenic Emissions*	Source
Carbon Dioxide (CO_2)	61%	Combustion of fossil fuels and deforestation
Methane (CH_4)	15%	Wide variety of agricultural and biological activities
Chloroflourocarbons (CFCs & HCFC-22)	12%	Industrial activities, aerosol propellants, other products
Nitrous Oxide (N_2O)	4%	Fertilizers, energy use
Other	8%	Chemical reactions from products of combustion

*This takes into account 1990 emissions only.

Source: 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

[36] As we discuss later, forests can play a mitigating role in this context, since *growing* trees (which are still increasing their biomass) remove CO_2 from the atmosphere, transforming it into biomass, while deforestation adds CO_2 to the air.

characterizing global climate change require projections of economic growth, energy production, and population in order to forecast future greenhouse-gas emissions and their climatic consequences. But such projections of socio-economic factors over a long time scale are notoriously unreliable. Hence, the best we can do is to identify alternative emission scenarios under various sets of assumptions about the future state of the world. The industrialized nations are primarily responsible for the buildup of greenhouse gases in the atmosphere. In the future, emissions from the developing nations will match, and eventually surpass, those in the developed world.

Consequences of Global Climate Change

Agriculture is probably the most weather-sensitive sector of our economy.[37] Changes in precipitation patterns could result in economic consequences for U.S. agriculture which would dwarf the consequences of recent major droughts, but climate change will redistribute climate resources in ways that will not necessarily be bad for all parts of the globe. While U.S. farming may suffer, Canadian and Soviet agriculture could benefit, with a consequent loss of competitive advantage for American agricultural exports.

In addition to climatic impacts on agriculture, a potential sea-level rise holds significant risks. Partly because water expands as it is heated, temperature increases associated with the greenhouse effect may cause some coastal areas to be inundated.[38] If there is partial melting of the polar ice caps, the effects would be greater, including more extensive damages to coastal infrastructure and investment, as well as such environmental resources as coastal wetlands, estuaries, and beaches.[39]

A third category of potential greenhouse impacts is the possibility of increased tropical storm intensity and associated coastal damages.[40] Because storm intensities depend upon temperature differences, however, global warming could also *reduce* the severity of such storms. As with the other possible consequences of global climate change, the most striking feature is the high degree of uncertainty associated with the magnitude of such changes and their regional implications.[41]

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[37]For a comprehensive review of potential effects of climate change in the U.S., see the Congressionally mandated EPA study: Smith, James B. and Dennis A. Tirpak, eds. *The Potential Effects of Global Climate Change on the United States*. Washington, D.C.: U.S. Environmental Protection Agency, 1989.

[38]The best current estimates suggest sea-level rises of 5.5 to 6.0 centimeters per decade. See: Houghton, Jenkins, and Ephraums 1990, *op. cit.*; and Jaeger 1987, *op. cit.*

[39]Cumulative costs of protecting densely developed shoreline areas of the U.S. from a 20-inch sea-level rise could be between $37 billion and $50 billion, or between $7 billion and $10 billion in present value if all costs were incurred in the year 2025. See: U.S. Council of Economic Advisers. *Economic Report of the President*. Transmitted to the Congress, February 1990. Washington, D.C.: U.S. Government Printing Office, 1990.

[40]For example, one study indicated that such damages could be as much as $1.4 billion annually in Charleston, South Carolina, and up to $500 million in Galveston, Texas. See: Barth, Michael C. and James G. Titus, eds. *Greenhouse Effect and Sea Level Rise*. New York: Van Nostrand Reinhold Company, 1984.

[41]There are arguments for waiting for more scientific information before proceeding with policy actions, since taking action too soon can be costly. If we mistakenly slow the rate of economic growth, we can probably never recover the lost output. On the other hand, postponing action in order to wait for more scientific information can be costly as well, since some climate changes

Current Federal Policies

An enormous number of Federal (and state) laws and regulations affect the rates at which greenhouse gases are produced, emitted, and absorbed, including policies which influence energy-use[42] and timber management practices, regulations affecting the use of CFCs under the Montreal Protocol, and a variety of government programs designed to produce improved energy efficiency or to subsidize research and development of non-fossil fuels. Despite -- and in some cases, because of -- Federal policies, however, fossil-fuel energy production and consumption remain inefficient. Two important examples are the widespread subsidization of energy consumption in general and the existence of energy prices which fail to reflect the true social costs of use (including potential environmental costs associated with global warming).

New Policies for Global Climate Change

Policies to help prevent or slow down global climate change can be designed to address either sources or sinks of greenhouse gases. The most prominent "sink" strategies involve expanding forested areas and encouraging plankton growth. Although reforestation could possibly play a very useful role as part of a portfolio of strategies to address global climate change,[43] the costs and land requirements for sole reliance on a forestation approach would be prohibitive.[44] Hence, most policy proposals have tended to focus on reducing greenhouse-gas emissions or adapting to global climate change. In particular, because of the likely importance of CO_2 in future greenhouse-induced warming, means of reducing fossil-fuel combustion are of special interest. At least two dozen bills intended to address global climate change have been introduced in the Congress.

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and associated damages may be irreversible. By the time precise information on costs and benefits becomes available, we may no longer have the option of averting continued, serious environmental costs. See: Lave, Lester B. "Formulating Greenhouse Policies in a Sea of Uncertainty." *The Energy Journal*, volume 12 (1991), number 1, pp. 9-21.

[42]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.

[43]See: Marland, Gregg. *The Prospect of Solving the CO_2 Problem through Global Reforestation*. Prepared for the U.S. Department of Energy by Oak Ridge Associated Universities and Oak Ridge National Laboratory, Oak Ridge, Tennessee, February 1988.

[44]One study suggested, for example, that a land area equal to the continent of Europe (3.8 million square miles or 2.4 billion acres) planted in American sycamores would be required to sequester about 50 years of CO_2 emissions in current annual terms. See: Seidel, Stephen and Dale Keyes. *Can We Delay a Greenhouse Warming?* EPA-230-10-84-001. Washington, D.C.: U.S. Environmental Protection Agency, November, 1983. Another study indicates that a program to reduce U.S. net emissions of CO_2 by 20% would involve about 140 million acres and cost $4.5 billion per year, an average of about $16 per ton of carbon sequestered. See: Moulton, Robert J. and Kenneth R. Richards. *Costs of Sequestering Carbon Through Tree Planting and Forest Management in the United States*. U.S. Department of Agriculture, Forest Service, General Technical Report WO-58. Washington, D.C., December 1990. In summary, although sequestration of carbon in biomass could be cost-effective for relatively low levels of CO_2 reductions, the marginal costs rapidly increase thereafter. See: Nordhaus, William D. "The Cost of Slowing Climate Change: A Survey." *The Energy Journal*, volume 12 (1991), number 1, pp. 37-65.

Policy makers would do well by examining three incentive-based approaches to addressing the potential threat of global climate change due to the greenhouse effect: international trading in greenhouse source/sink permits; carbon charges or fees; and comprehensive least-cost bidding.

INTERNATIONAL TRADING IN GREENHOUSE GAS SOURCE/SINK PERMITS

A policy approach which could be utilized collectively by the community of nations to deal with one of the most troubling obstacles to addressing the global climate change problem -- how to allocate control responsibility among nations -- revolves around international trading in greenhouse gas reduction permits. A permit-trading scheme could also be adopted by individual countries to allocate control responsibility domestically, as we discuss later in the chapter. Trading could thus be employed either on its own or in conjunction with the domestic policy mechanisms we later consider -- carbon charges and least-cost planning/bidding.

Overview of Greenhouse-Permit Trading

A tradeable-permit program for greenhouse gases would be a new application of a market-based approach already applied in the U.S. to lead-permit trading among refiners, transferable production permits for CFCs, and SO_2 trading for acid-rain prevention.[45] Economic-incentive policies in general, and emissions trading in particular, are well suited for the management of uniformly-mixed air pollution problems, such as acid rain and global climate change. These policy mechanisms allow for *aggregate* pollution reductions at minimum cost to society at large. With essentially uniformly-mixed air pollutants, ultimate concern is on *aggregate* pollution levels, as opposed to specific emissions from individual sources.

With emissions trading, pollution reductions can be achieved at lower aggregate cost to society since polluters are given flexibility in pollution-control investments. Our previous experiences with trading indicate that cost savings can be realized and environmental standards can be met.[46] Under an international system of greenhouse emissions trading, nations could be assigned a baseline which would establish the initial emissions levels from which reductions would be assessed. Each country would have to meet its minimum standard, but could do so either by controlling emissions or by purchasing reduction credits from nations which exceeded their own standard. A tradeable-permit system would essentially implement a regulatory program that sets overall limits on emissions of CO_2 or limits on combustion of fossil fuel or deforestation.

After establishing responsibility among nations (as in the Montreal Protocol in the case of CFCs), permits, transferable among nations, could be used to ensure that emission reduction goals are cost-effectively distributed among participating nations. Individual countries could thus achieve their respective control

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[45]This part of the chapter draws, in part, upon a paper prepared for Project 88/Round II by Daniel J. Dudek, "International Trading in Greenhouse Gas Permits." These previous applications of tradeable permits are discussed briefly in Chapter 1.

[46]Hahn, Robert and Gordon Hester. "Where Did All the Markets Go? An Analysis of EPA's Emissions Trading Program." *Yale Journal on Regulation* 6(1989):109-153; and Liroff, Richard. *Reforming Air Pollution Regulation: The Toil and Trouble of EPA's Bubble*. Washington, D.C.: Conservation Foundation, 1986.

obligations through any means chosen. In this way, an international CO_2 or greenhouse gas trading program could accommodate a variety of separate national implementation strategies. Once international agreement had been reached on the initial allocation of targets *and* the "globally cost-effective" reallocation among nations had been achieved via the tradeable permit system, the U.S. and other nations might choose to meet their control targets through some combination of carbon charges, least-cost planning/bidding, domestic tradeable permits, or other incentive-based and conventional regulatory policies.

Potential advantages of using marketable permits in the global greenhouse context include: (a) flexibility; (b) direct control of aggregate emission levels; (c) cost-effectiveness in pollution control; (d) provision of mechanisms for trading among different greenhouse gases; (e) dynamic incentives for development of low-polluting technologies and management strategies; and (f) establishment of an explicit linkage of self-interest along the often divisive north/south axis, linking sources and sinks in a single comprehensive strategy.

Designing an International Greenhouse Gas Trading System

In order to develop an effective and practical trading system, consideration should be given to a number of policy design issues. Among these are: (1) exclusive source programs versus source/sink programs; (2) CO_2 versus multiple-gas trading; (3) aggregate target levels; (4) initial allocation of control responsibility among nations; (5) technology transfers to less developed countries; and (6) monitoring and enforcement problems.

(1) Should Sinks As Well As Sources Be Included?

Should an international CO_2 trading program consider only changes in emissions of CO_2 or also changes in CO_2 sinks, such as forests? Since growing forests remove carbon from the atmosphere and their burning or destruction contributes to global CO_2 loadings, one question is whether and how an international agreement might help retard deforestation and promote reforestation. With a tradeable-permit program for CO_2, countries like Brazil and Indonesia might find it economically attractive, as well as environmentally sound, to retard the depletion of their forests or to implement reforestation programs in order to earn CO_2 credits which their own industries could use or which they could sell to foreign governments. Those countries in turn could use the revenues from the sale of such credits to finance programs to retard forest loss.[47] Depending upon the initial distribution of CO_2 permits (reduction responsibilities), an international trading program could contain an explicit mechanism for north-south flows of funds.

[47]Defining quantitatively the magnitude, size, and rates of loss of sinks, such as forests, would be an enormous undertaking. Satellite monitoring is a critical tool. This effort must be made, however, whether or not international trading of credits involving sinks is authorized, so long as CO_2 emissions from destruction or creation of such sinks is incorporated into a convention.

(2) CO_2 Versus Multiple Greenhouse Gas Trading

There has been considerable debate in the U.S. regarding whether to focus on CO_2 alone for a trading program or to focus on all greenhouse gases.[48] The advantage of the more comprehensive approach is the additional flexibility it introduces into the system and hence the potential it creates for even greater cost effectiveness.[49] On the other hand, such a system would increase administrative burdens and require greater scientific understanding of the inter-relationships among the suite of greenhouse gases.[50] One option is to introduce gradually other gases into the trading framework, contingent upon increased scientific knowledge about these gases. Experience suggests that when and if there is significant profit potential, firms or nations will eventually cooperate in the development of baselines, budgets, and appropriate certification methods for all of the greenhouse gases.[51]

(3) Aggregate Target Levels

Any international greenhouse gas reduction policy presumes some agreed upon aggregate goal for management of greenhouse gas emissions into the atmosphere, translated into an allowable level of emissions over time. The goal can be framed initially as a fixed level of ambient greenhouse gas concentrations. This level can be established as a reduction from a baseline, either historic or projected. Once established globally, however, these allowable emissions must be distributed to individual nations.

(4) Initial Allocation of Control Responsibility Among Nations

The most difficult problem associated with *any* international greenhouse-gas control program will be achieving agreement on both the global emissions cap and initial, individual national control obligations. The trading program highlights this problem because it makes it explicit. Since the program would create a new environmental "currency" denominated in tons of CO_2 (as the numeraire gas for example), every nation will know immediately its reduction responsibilities.

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[48]For further discussion of the arguments in favor of the multi-gas approach, see: Stewart, Richard B. and Jonathan B. Wiener. "A Comprehensive Approach to Climate Change." *The American Enterprise*, volume 1, number 6, November/December 1990, pp. 75-80.

[49]See: Cristofaro, Alexander and Joel D. Scheraga. "Policy Implications of a Comprehensive Greenhouse Gas Budget." Working paper, Office of Policy Analysis, Office of Policy, Planning, and Evaluation, U.S. Environmental Protection Agency, Washington, D.C., September 1990.

[50]Arguments against the multi-gas approach are found in: Victor, David G. "Tradeable Permits and Greenhouse Gas Reductions: Some Issues for U.S. Negotiators." Global Environmental Policy Project Discussion Paper G-90-06, John F. Kennedy School of Government, Harvard University, Cambridge, Massachusetts, May 1990.

[51]A recent example of such cooperation is the toxicological testing of alternatives to CFCs funded by several major chemical firms.

A variety of alternative allocation mechanisms have been suggested, including allocations based upon GNP, real GNP, total population, adult population, land area, and emissions.[52] There are numerous other possibilities. Each of these criteria will have adherents, largely those with larger allocations under that criterion. Several criteria may need to be blended to create international consensus on emission allocations. Whatever the initial allocation, subsequent trading can lead to a cost-effective outcome. This potential for pursuing distributional objectives while assuring cost-effectiveness is an important attribute of the tradeable permit approach.

Most proposals for allocating control obligations among nations[53] call for proportionately higher rates of reduction in emissions by the industrialized countries (and, among the industrialized countries, by the United States) and substantial reductions in the predicted rates of increase in CO_2 emissions by most developing countries. Any convention will have to deal with the issue of establishing global and national baselines.

(5) Technology Transfers to Less Developed Countries

A trading system would provide industry with economic incentives to develop and use more efficient energy technologies and to switch to non-fossil or less carbon-intensive fuels. Internationally, a properly designed trading program could promote transfer of energy-efficient technologies from highly industrialized to less developed countries (LDCs).[54] For example, the potential of a developed country to obtain credits in an LDC by investing in increased appliances efficiency could create an economic incentive on the part of firms in industrialized counties to transfer technology and, in effect, finance the transfer of that technology. A well designed protocol that encourages such international trading of energy credits could promote least-cost energy efficiency investments (as well as renewable energy investments) on an international basis. As a general proposition, the tougher the CO_2 reduction goals that industrialized countries must meet, the more they will be inclined to look for opportunities in less developed countries as a source of credits.

(6) Monitoring and Enforcement Requirements

Effective monitoring and enforcement provisions are essential in the design of any environmental policy mechanism. This need arises for international tradeable permits, as well as any other international agreements to reduce greenhouse gas emissions. Even basic monitoring of compliance will be a formidable

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[52]See: Grubb, Michael. "The Greenhouse Effect: Negotiating Targets." London: Royal Institute of International Affairs, 1989.

[53]See, for example: Krause, Florentin. *Energy Policy in the Greenhouse: From Warming Fate to Warming Limit -- Benchmarks for a Global Climate Convention*. The Hague: Dutch Ministry of Housing, Physical Planning and Environment and the European Environmental Bureau, 1989; Flavin, Christopher. "Slowing Global Warming: A Worldwide Strategy." Worldwatch Paper 91. Washington, D.C.: Worldwatch Institute, October 1989; and Wirth, David and Daniel Lashof. "Beyond Vienna and Montreal -- Multilateral Agreements on Greenhouse Gases." *Ambio* 19(1990):305-310.

[54]For further discussion, see: Tripp, James T. B. and Daniel J. Dudek. "Comments on the IPCC Working Group III Economic Measures Paper." New York: Environmental Defense Fund, January 1990. For examinations of the international distributional implications of CO_2 controls, see: Manne, Alan S. and Richard G. Richels. "Global CO_2 Emission Reductions -- The Impacts of Rising Energy Costs." *The Energy Journal*, volume 12 (1991), number 1, pp. 87-107; and Pearce, David and Edward Barbier. "The Greenhouse Effect: A View from Europe." *The Energy Journal*, volume 12 (1991), number 1, pp. 147-160.

challenge. One only need take note of the widely varying estimates of Brazil's rate of deforestation to appreciate the problem.

Clearly, there are significant tradeoffs between monitoring ease and accuracy. For example, it would be theoretically desirable to allow full flexibility for nations to achieve their emissions targets (permit levels) through any means they might choose, including reduced fossil-fuel combustion, on the one hand, and reforestation, on the other. But this would also necessitate an extremely expensive monitoring system *or* the adoption of some simplifying assumptions (regarding the impact of given fuel uses on emissions and the relative impacts of various reforestation programs).

Will these and other design problems overshadow the potential advantages offered by an international greenhouse gas permit trading program? The answer will depend, in part, on the skills of those negotiating the international framework agreements.

USING CHARGES TO COMBAT GLOBAL CLIMATE CHANGE

Whether or not an international tradeable permit mechanism is used to reallocate greenhouse targets among nations (subsequent to international negotiations of initial target levels), individual countries will have to decide how to control emissions under an international agreement. In this part of the chapter, we examine how the U.S. could work to achieve internationally-imposed national targets effectively and at minimum cost to society at large. We focus our attention on a promising set of cost-effective mechanisms -- CO_2 charges or fees to address the problem of global climate change due to the greenhouse effect.[55]

CO_2 or greenhouse charges could take various forms.[56] One possibility would be a "carbon charge" -- a tax on coal, oil, and natural gas, with the tax rate on each fuel based on its carbon content.[57] Because CO_2 emissions are generally proportional to the carbon contained in a particular fuel, a carbon charge is effectively equivalent to a CO_2 emissions charge.[58] Alternatively, a greenhouse charge could take the form of a BTU charge -- a tax on fossil fuels based on energy produced, rather than carbon content. A third, and more narrow example of a greenhouse charge would be an increase in the Federal gasoline tax. We discuss each of these possibilities, although we focus by way of example on the first alternative, the carbon charge. Most of the design issues we investigate, however, will arise with any kind of fossil fuel (CO_2) charge.

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[55]This part of the chapter draws, in part, upon a paper prepared for Project 88/Round II by Lawrence H. Goulder, "Using Carbon Charges to Combat Global Climate Change."

[56]For purposes of simplicity, we limit our investigation of greenhouse charge systems to those linked with CO_2. As with tradeable permits, however, it would be possible to design comprehensive charge systems which embraced other greenhouse gases as well.

[57]This idea, which has come to be considered by policy-makers only recently, dates back at least to: William D. Nordhaus. "How Fast Should We Graze the Global Commons?" *American Economic Review* 72(1982):242-246.

[58]In 1990, Finland introduced what may be the world's first "carbon tax." The charge on fossil fuels is based on their carbon content, and the rate is $6.10 per ton of carbon emissions. Sweden and the Netherlands are developing similar programs. See: "Where There's Muck There's Brass." *The Economist*, March 17, 1990, pp. 46-47.

Before we turn to an overview of CO_2 charges, we should acknowledge that whereas we focused on tradeable-permit approaches to the international-allocation problem of greenhouse targets, we are focusing on charge approaches to the problem of achieving given targets within individual nations. Some analysts have argued for reliance on tradeable permits for both tasks[59] and others have argued for exclusive reliance on charge systems.[60]

In the domestic context, there are advantages and disadvantages related to both charges and tradeable permits. Which one is most appropriate depends partly upon the tradeoffs decision makers are willing to make between administrative complexity and emission-control costs and goals. A carbon charge would be relatively easy to administer, but difficult to gauge in advance in terms of eventual pollution reduction. With tradeable permits, targets can be stipulated in terms of specific emission levels. Yet, the costs of a permit system can be difficult to predict. With a charge, controls that cost more than the charge level will simply not be implemented, thereby placing a known upper limit on the marginal cost of control.

Additionally, general price inflation or economic growth can erode the effect of a charge system, but have no effect on the level of control achieved with tradeable permits. One factor which can be argued either way is the fact that the U.S. government is developing substantial experience with the use of tradeable-permit systems, but EPA has no experience with pollution charges. On the other hand, the Federal experience with excise taxes and state experiences with sales taxes would be relevant to the carbon charge.

With advantages and disadvantages on the sides of both charges and tradeable permits, both merit further investigation and consideration. In general, most analysts believe that *tradeable permit systems* would be preferable to charges in the international context of allocating national targets *among nations*, while *charge systems* may be practical for the task of allocating the control burden *among firms within a given nation*, such as the U.S. Since we have already examined tradeable permits in the international-allocation context, we will now focus on systems of charges and fees in the domestic context.

Overview of CO_2 Charges

A properly designed carbon charge can enable the U.S. to achieve a national CO_2 target cost effectively by increasing the cost of CO_2 emissions (via a tax) and possibly by decreasing the cost of CO_2 sinks (via a tax credit). By altering price signals, a charge based on the carbon content of fuels, for example, can internalize the potential costs of climate change. Higher fossil fuel prices would reduce demand for fossil fuels and stimulate the development of new technologies that are less carbon intensive. In these ways, the charge reduces demands for fossil fuels and thereby reduces emissions of carbon dioxide.

Compared with exclusive reliance on standards and other conventional regulatory approaches to achieve the same objective, a carbon-charge program could achieve given targets at a lower aggregate cost to society. As we explained in Chapter 1, this is because a charge system would encourage low-cost

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[59]See, for example: Dudek, Daniel and Alice LeBlanc. "Offsetting New CO_2 Emissions: A Rational First Greenhouse Policy Step." *Contemporary Policy Issues*, volume 8, number 3, July 1990, pp. 29-42.

[60]See, for example: 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.

controllers to take on an added control burden and because it would give firms flexibility in deciding how to comply.

The carbon charge is a "corrective" tax, one that helps improve the functioning of the market, in contrast with most other taxes, which tend to distort the functioning of the market.[61] Thus, whereas corporate profit taxes, Social Security and other payroll taxes, and personal income taxes *generate* market inefficiencies, a corrective tax, such as a carbon charge, actually *reduces* them. The corrective nature of the carbon charge generates a "double dividend:" in addition to providing incentives to achieve a CO_2 target, the carbon charge (revenues) could be used as an offset for reductions in distortionary taxes. This is an important distinction, particularly in today's political climate, in which policy makers are reluctant to consider any new tax options. Thus, a revenue-neutral tax policy change, which combines the introduction of carbon charges and the reduction or elimination of other taxes, would protect the environment by reducing CO_2 emissions *and* reduce distortions associated with other taxes. Such a shift in tax policy would reorient taxes toward socially undesirable activities (pollution) and away from socially beneficial activities (labor and capital formation).

The carbon charge enjoys several additional attractions compared with other regulatory approaches to reducing fossil-fuel use. First, relative to regulatory standards that impose limits on fossil-fuel burning, the charge would be less expensive to administer. All of the fossil fuels are used in many distinct industries. Cost effectiveness would require different standards for each of the industrial, commercial, and residential uses of each fuel. Given the thousands of uses involved, determining, monitoring, and enforcing standards would be very costly, to say the least. In contrast, a carbon charge would require relatively few tax rates, set on the basis of the carbon content of the various fossil fuels.

Secondly, in contrast with command-and-control measures, a carbon charge would also create greater ongoing incentives for technological innovation. Once a firm's use of a particular fossil fuel is reduced below the command-and-control standard for that industry, no further incentive drives a firm to reduce its fuel use. With a carbon charge, however, a firm can continue to reduce its tax obligation wherever fossil fuel consumption can be cut.

Despite many attractive features, the carbon charge approach is not without its disadvantages. These include its distributional impact across income groups, its regional impacts in the U.S., and its effects on the international competitiveness of U.S. industries. We examine these potential problems below, as they must be considered in the design of an effective charge system.

Designing a Charge System

In order to develop a domestic CO_2 charge system which possesses the positive attributes described above, it will be important to consider a variety of critical design issues. Among these are: (1) the base for the charge (carbon, BTUs, or other); (2) the level of the charge; (3) options for revenue neutrality; (4) incidence across industries; and (5) incidence across incomes.

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

(1) The Base for a CO_2 Charge: Carbon Content, BTUs, or Gasoline Taxes

The goal of the charge system would be to (cost-effectively) achieve (internationally agreed upon) national CO_2 emission targets.[62] Hence, on a theoretical basis, the ideal charge system would be based upon the quantity of CO_2 emitted. The vast number of individual sources of CO_2 emissions clearly argues against the practicality of such a system, however. Instead, consideration should be given to a charge on coal, crude oil, natural gas, and other fossil fuels, based on the fuel's carbon content,[63] since carbon content is roughly proportional to the amount of CO_2 released when fossil fuels are burned.

The carbon charge could be imposed at the point of entry for imported fuels and at the point of primary production for domestic fuels. Thus, the fee could be applied to: shipments from coal mines, crude oil received at refineries, and natural gas received by pipelines. There would be no need for additional charges on refined petroleum products or on other goods derived from fossil fuels.

A viable alternative to the carbon charge is a BTU charge, with the tax being based on the energy produced in burning the fuel rather than on the fuel's carbon content (and CO_2 released). If our principal goal is to reduce CO_2 emissions, the carbon charge is theoretically superior, because it targets more effectively the source of emissions: a carbon charge will induce greater CO_2 reductions than a BTU charge that imposes the same costs. On the other hand, if the BTU charge is applied only to fossil fuels, the difference in cost-effectiveness between the two is not dramatic.[64]

Another alternative frequently discussed is an increase in the Federal gasoline tax. Because the carbon charge has a broader base than a gasoline tax, its industry effects would be spread more uniformly. Furthermore, a gasoline tax would be less effective than a carbon charge in reducing CO_2 emissions per dollar of revenue raised, for the same reasons as discussed above in the context of a BTU tax.

The relative attractiveness of one policy compared with another depends again on our objectives. A gasoline tax is a legitimate instrument for dealing with environmental problems closely related to the burning of gasoline.[65] Likewise, increased gasoline taxes could have significant energy-security benefits by reducing

[62]To keep the discussion simple, we ignore here the possibility -- already acknowledged -- of including rebates as well as charges, so that the system would encourage increased (forestation) sinks, as well as reduced emissions.

[63]Non-combustible feedstocks should be exempted.

[64]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.

[65]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.

the nation's overall demand for petroleum products.[66] In principle, there may be arguments in favor of both a carbon or BTU charge *and* a gasoline tax. But, the public may only tolerate one new Federal tax initiative. A pragmatic approach may simply be to concentrate efforts on a carbon or BTU charge at the Federal level, and to leave considerations of gasoline-tax changes to the states.

In the remaining sections of this part of the chapter, we focus on the carbon-base approach to CO_2 charges, by way of example. Nearly all of the design issues considered, however, would also arise in the context of BTU charges and gasoline taxes.

(2) Level of a Carbon Charge

The carbon charge should be set so that it will encourage sufficient reductions in CO_2 emissions to achieve whatever national CO_2 targets the country faces (as a result of international negotiations). This is easier said than done. While it is clear that a carbon charge could bring about significant reductions in fossil-fuel use, there are very large uncertainties regarding the likely magnitude of impacts.

The Congressional Budget Office has consolidated projections of the effects of carbon charges. Results indicate that a $100/ton carbon charge phased in over ten years would lead to reductions in U.S. CO_2 emissions of 8% to 36% by the year 2000,[67] relative to the emissions that would occur absent a charge.[68] How large a carbon charge would be needed to reduce CO_2 emissions by 20% from their 1990 levels? According to one rather pessimistic analysis,[69] a charge ranging from $200-$400 per ton would be required to achieve a 20% reduction in CO_2 emissions from their 1990 levels between 2010 and 2040; in the longer term (2050 and beyond), a $250/ton charge would be needed to maintain emissions at a level 20% below current levels.

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

[67]In contrast to the 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: Lashof and Tirpak, *op. cit.*

[68]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.

[69]See: Manne, 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.

(3) Possibility of Revenue Neutrality

The revenues generated by carbon charges of the magnitude described above would be enormous, due to the pervasiveness of fossil fuel use in the U.S. economy. The Congressional Budget Office estimates that a $100/ton carbon charge in the year 2000 would generate approximately $120 billion in annual revenue.[70] There are at least three ways this revenue could be used: to finance environmental programs; to reduce the Federal budget deficit; or to offset reductions in other taxes. The first option -- using the tax revenue to finance other environmental programs -- allows a variety of environmental programs to be funded without having to resort to increases in distortionary taxes. The second option -- reducing the Federal budget deficit -- has obvious appeal. On balance, however, the third option -- using carbon tax revenue to offset reductions in other taxes -- may be the most attractive of all.

Linking a carbon charge to reductions in other taxes would make it possible to lessen both the potentially regressive effects of the tax and the potentially adverse effects on the international competitive position of U.S. firms.[71] These features could be critical to political acceptability of the carbon charge. Another appealing feature of a revenue-neutral charge system is the "double dividend" previously mentioned: protecting environmental quality while simultaneously reducing the size (and distortions) of other taxes.

(4) Implications for U.S. Industry

The impacts of a carbon charge on U.S. economic activity cannot be overlooked. The best available evidence suggests that a phased-in $100/ton carbon charge would lead to a 2% annual loss in GNP from baseline projections by the time the charge was fully implemented *if* such a charge were unilaterally adopted by the U.S.[72] The impact would be substantially less if other nations acted in concert, a precondition for the policy proposal we are examining. In addition, the 2% loss in GNP could be greatly lessened if a revenue-neutral charge were designed to reduce, correspondingly, other taxes, such as the Social Security payroll tax, for example.

GNP losses associated with a non-revenue neutral charge would occur from reduced employment due to price changes and induced shifts in industry employment and investment patterns. Because it takes time for labor markets to adjust to the changing composition of employment demands, some short-term unemployment could result. The evidence indicates, however, that even a unilateral carbon charge would

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[70]The projected revenue is expressed in 1988 dollars. See: U.S. Congressional Budget Office. "Carbon Charges." *op. cit.* A study performed on behalf of the American Petroleum Institute estimates that a $20/ton (1¢/pound) carbon charge would generate $30 billion in annual revenues. See: Anderson, Robert, Lisa Hofmann, and Michael Rusin. *The Use of Economic Incentive Mechanisms in Environmental Management*. Research Paper #051. Washington, D.C.: American Petroleum Institute, June 1990.

[71]It is important to keep in mind that we are considering the carbon charge in the context of meeting national targets imposed upon the U.S. through international negotiations, international tradeable permits, or some combination of the two. Thus, the U.S. carbon charge would presumably be undertaken in concert with policy actions (whether incentive-based or conventional) by other nations to meet their own CO_2 targets.

[72]The short-run losses would be more severe under a charge which was imposed suddenly. For a discussion of the effects of such a policy, see: U.S. Congressional Budget Office. *Carbon Charges*, *op. cit.*, p. 36.

reduce employment by a maximum of 0.52% in the first two to three years following its implementation and less thereafter.

The bulk of the reduction in fuel demand caused by the carbon charge would come from coal. A phased-in $100/ton carbon charge could reduce overall coal use (relative to baseline projections) by up to 13% in the year 2000, as compared with reductions of 6% for oil and 4% for natural gas.[73] Among electric utilities, which account for about 80% of all U.S. coal consumption, there would be some substitution of oil and natural gas for coal. This conversion may be mitigated somewhat in the longer run by an overall decline in energy demand. Perhaps the largest potential gainers would be the producers of energy from non-fossil fuel sources, including nuclear, geothermal, and solar, as well as energy efficiency.

With multilateral action, the effect of domestic charges on the competitiveness of U.S. industries depends on the global distribution of targets/permits and the consequent effect on the relative prices of traded goods.[74] Although we are focusing on carbon charge systems in the context of concerted international action, we can at least ask what the implications of a carbon charge would be for the international competitiveness of U.S. industries *if* such a system were adopted unilaterally. First of all, if the carbon charge were applied both to domestic and imported fossil fuels, it need not directly harm domestic fossil-fuel producers, relative to their foreign competitors. It could have an effect, however, on domestic producers of fossil-fuel-intensive products, relative to foreign manufacturers. If the charge were accompanied by a revenue-preserving cut in another tax, these effects would be somewhat mitigated, but not eliminated. Adverse effects on international competitiveness could be reduced further if the carbon-charge policy included a tax on imported products[75] based on their "carbon content,"[76] although the administrative costs and complexity of imposing such a charge might be prohibitive.

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[73]The Dynamic General Equilibrium Model (DGEM) developed by Dale Jorgenson tends to predict larger percentage reductions, particularly in the case of coal. An extension of this model has been developed in recent years by Jorgenson and Peter Wilcoxen. See: Jorgenson, Dale and Peter Wilcoxen. "Environmental Regulation and U.S. Economic Growth." *The RAND Journal of Economics* 21(1990):314-340.

[74]For an investigation of the effect of energy-price increases on productivity, see: Hogan, William W. and Dale W. Jorgenson. "Productivity Trends and the Cost of Reducing CO_2 Emissions." *The Energy Journal*, volume 12 (1991), number 1, pp. 67-85.

[75]As long as the import duty accurately reflects a domestic tax, this would be permissible under the General Agreement on Tariffs and Trade (GATT) and the Canadian Free Trade Agreements. The recently enacted CFC tax provides a precedent for this approach.

[76]Further, a carbon tax rebate could be allowed for exports of fuels and carbon-intensive goods. Importing countries would then have the option of imposing their own carbon tax on these goods. This would place a part of U.S. CO_2 emissions outside of the carbon charge. Relatively few U.S. industries, however, produce predominantly for export markets, and so the incentive to cut domestic emissions should not be significantly weakened.

(5) Equity Concerns

Given the magnitude of reduction targets which have frequently been discussed by policy makers and given the pervasiveness of fossil-fuel energy use in our economy, it is to be expected that achieving greenhouse goals such as a 20% reduction of CO_2 emissions could entail very substantial costs. This was documented in the previous section. An important question is whether this burden will be evenly distributed across income classes. This burden comes in two forms -- the tax itself (and its appearance in prices of various goods and services), and increased real prices resulting from expenditures on improved efficiency of energy generation and use, shifts away from high CO_2-emitting fuels, and other measures to reduce CO_2 emissions.[77]

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 CO_2 charge could potentially have a regressive impact. A revenue-neutral approach could serve to mitigate some, if not all, of the impacts on low-income households resulting from the tax itself, but there is little doubt that real incomes would fall for some members of society. This would be due both to the direct tax effects and to price increases associated with the costs of reducing CO_2 emissions. Individuals who derive income from fossil-fuel-oriented firms would likely experience at least a temporary loss in real income relative to other individuals. However, there is no reason to expect a greater proportion of low income individuals to fall in this category than higher income individuals.

A further concern might be the regional distribution of the burden of charges since some regions of the country would likely bear larger burdens than others. It should be recognized, however, that regional impacts would be essentially the same if a conventional emission-standard approach were adopted. Furthermore, to the extent that adverse impacts merit special consideration, the policy could be designed to provide for some form of adjustment assistance, mitigation, or compensation, such as job training or job-search programs for displaced workers.

COMPREHENSIVE LEAST-COST ENVIRONMENTAL BIDDING & PLANNING

We have now investigated two greenhouse policy mechanisms in the context of international cooperative action -- international permit trading as a means of cost-effectively allocating the CO_2 control burden among nations, and charge systems as a cost-effective means of achieving (internationally established) domestic targets. This does not imply that the U.S. should not undertake any actions in the absence of concerted international agreements. A variety of policies to encourage increased energy efficiency can have positive net environmental and economic benefits for the United States, regardless of their implications for global climate change. In this final part of the chapter, we examine one such cost-effective inducement for increased energy efficiency -- comprehensive environmental least-cost utility planning and bidding.[78]

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[77]For a review of technical options for reducing CO_2 emissions, see: U.S. Congress, Office of Technology Assessment. *Changing by Degrees: Steps to Reduce Greenhouse Gases*. OTA-O-483. Washington, D.C., February 1991.

[78]This part of the chapter draws, in part, upon a paper prepared for Project 88/Round II by Ralph Cavanagh, "Comprehensive and Environmental Least-Cost Planning and Bidding."

Energy production is an important leverage point for addressing the problem of global climate change, and the single most important point of leverage in the U.S. energy system is the regulated utility sector that distributes electricity and natural gas. Energy distributed by utilities accounts for almost half of U.S. carbon dioxide emissions (and more than two-thirds of sulfur dioxide emissions). It is in this sector that the recent growth in both energy use and carbon dioxide emissions has been most rapid.

Increased energy efficiency through electricity conservation is one obvious approach to this problem, but critics of conservation programs claim that energy conservation potentials have been overestimated and costs underestimated. Proponents of energy conservation programs disagree on both counts. Rather than trying to resolve this debate among experts and idealogues, one possible approach is to give energy producers and consumers the information and the means necessary to make decisions between energy consumption and energy conservation so that they, not competing experts, can decide on the ultimate portfolio of savings and use.

There is reason to believe that the current playing-field is skewed, and that there is "underinvestment" in energy efficiency (conservation) as a result. First, regulation typically requires utilities to under-price electricity by basing customer charges on the average cost of the existing mix of energy sources, rather than pricing on the basis of the incremental (marginal) cost of the newest source. Second, some consumers do not incur their electricity costs directly (such as apartment dwellers who are not separately metered), and hence have little incentive to conserve. Third, the price of electricity does not reflect its full social costs, including environmental costs. Fourth, consumers lack full information to evaluate the cost-effectiveness of conservation alternatives (such as light bulbs which consume less energy, but have relatively high initial costs).

One result of these factors has been a likely bias toward consumption and against efficiency in the current energy marketplace,[79] leading prospective investors in efficiency to pass up opportunities with returns better than those which can be earned on energy-generation facilities. In some cases, consumers and businesses seem to expect long-lived efficiency improvements to repay their full costs in three years or less, a return of more than 35% per year on the money invested.[80] Such expectations contrast with those of investors in energy production, where many large-scale energy projects do not begin earning profits for a decade or more.

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[79]See: Cavanagh, Ralph. "Responsible Power Marketing in an Increasingly Competitive Era." *Yale Journal on Regulation* 5(1988):342-43; National Association of Regulatory Utility Commissioners. *Least-Cost Utility Planning Handbook, Volume II*. Washington, D.C., December 1988; and Massachusetts Department of Public Utilities, D.P.U. 86-36-F, November 1988.

[80]See, for example: Hausman, Jerry A. "Individual Discount Rates and the Purchase and Utilization of Energy-Using Durables." *The Bell Journal of Economics* 10(1979):33-54; and Norberg-Bohm, Vicky. "Potential for Carbon Dioxide Emissions Reductions in Buildings." *Global Environmental Policy Project Discussion Paper*, Energy and Environmental Policy Center, John F. Kennedy School of Government, Harvard University, 1990. Empirical evidence suggests that automobile buyers, however, rationally anticipate the significance of future energy costs. See, for example: Daly, George G. and Thomas H. Mayer. "Reason and Rationality During Energy Crises." *Journal of Political Economy* 91(1983):168-181; and Kahn, James A. "Gasoline Prices and the Used Automobile Market: A Rational Expectations Pricing Approach." *Quarterly Journal of Economics* 101(1986):323-340.

Overview of Least-Cost Bidding and Planning

For purposes of meeting the needs of a growing economy and population, energy saved from improved efficiency is essentially indistinguishable from energy delivered to customers by production facilities. Energy savings created in large quantity on a *predictable* schedule may be thought of as energy resources, just like generators, oil fields, or gas wells. If we see a need for increased supply or for replacing output from obsolete facilities, we should weigh our conservation options against our production technologies and choose the best buys first.

In other words, U.S. power markets should be opened up to allow "efficiency contractors" to compete with power producers through *comprehensive* least-cost bidding at electrical utilities. By also taking into account the environmental costs of alternative sources, the approach could theoretically be expanded to one of comprehensive *environmental* least-cost bidding/planning. Under the conventional regulatory approach, an operating utility offers to purchase a given amount of capacity with specified characteristics of reliability and timing of generation. An auction takes place in which providers of electric energy services offer to meet the utility's needs. The utility then selects the most economical option. By extending this process to include demand-side actions, potential contractors could offer bids based upon savings in power use.[81] Since the utility's capacity problem is fundamentally one of demand exceeding supply, there is no reason to limit possible solutions to those that augment supply; means of curtailing demand can also be effective.

The efficient approach would be to utilize whatever solution is least expensive, be it on the supply side or the demand side. Thus, for example, the bidding process could allow conservation marketing and non-utility generation to compete with nuclear and conventional fossil-fuel generators on a least-cost basis.[82] An oil refinery could bid to provide power from cogeneration -- or to free up power for the utility by leaving the utility grid and generating its own power.

Variations on the least-cost bidding theme are emerging in at least 21 states.[83] The functional equivalence of conserved and produced power is understood, and techniques for comparing ways to do both have evolved under the rubric of "least-cost energy planning." If electricity demand threatens to outstrip the current resource base, for example, least-cost planners might investigate whether efficiency improvements in residences, commercial buildings, and industries could meet these needs at a lower cost per kilowatt-hour delivered than additional power generation.[84] This is not a call for a centrally dictated program; the goal is

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[81]In order to provide an appropriate basis for the comparison of demand-side programs with conventional supply-side options, it is important that an "unbundled bidding system" be used, in which a distinction is made between energy services and energy products. See: Cicchetti, Charles and William Hogan. "Including Unbundled Demand Side Options in Electric Utility Bidding Programs." *Public Utilities Fortnightly*, June 8, 1989, pp. 9-20.

[82]Demand-side options include funding of conservation investments, promotion of appliance efficiency, audit services, and educational programs. See: Goldman, C., E. Hirst, and F. Krause. *Least-Cost Planning in the Utility Sector: Progress and Challenges*. Oak Ridge National Laboratory, May 1989.

[83]Mitchell, Cynthia. "Lagging in Least-Cost Planning -- Not as Far Along as We Thought." *The Electricity Journal*, December 1989.

[84]Costs must be evaluated, of course, over the anticipated life cycles of the competing conservation and power plant options. Differences in *reliability* of various alternatives will complicate the required analysis.

to help energy markets work better, not to replace them. Furthermore, it is not a call for expansion of utilities' legal monopolies into the realm of conservation, but rather a call for giving competitive markets the necessary information and incentives to supply demand-reducing investments.

Designing Least-Cost Bidding and Planning Systems

Electrical utilities are characterized by: their monopoly franchises to operate within geographically defined service areas; their legal obligations to meet any growth in demand for electricity and natural gas within their service areas; and their regulation through complex state rules covering pricing, profits, and most aspects of resource planning and investment. Although states dominate the utility regulatory arena, the Federal government has a potentially significant role through the Federal Energy Regulatory Commission's (FERC) supervision of interstate power sales and natural gas transfers.

Utilities are uniquely equipped to promote improved efficiencies in the end-uses they serve, but a transition to large-scale implementation of least-cost energy planning/bidding has yet to occur. Many utilities lack financial incentives to promote efficiency; indeed, an unintended consequence of most states' utility regulation is a set of disincentives for utility actions which would reduce demand. Strategies for removing at least some of these barriers are available. These strategies tend to be linked with three design issues: restructuring utilities' financial incentives; designing better competitive mechanisms for allocating investment in new energy supply; and quantifying and internalizing environmental costs.

(1) Restructuring Utilities' Financial Incentives

Current regulatory systems provide utilities with little incentive to invest in energy efficiency, even where such investments would be substantially less expensive than alternative sources of energy supply. Many regulators now strongly endorse the rationale for such investments, but relatively few have moved to make them a potential profit center for utilities. In many states, conservation investment remains unprofitable for utilities because foregone revenues from unsold electricity (or natural gas) overwhelm returns that the utility is permitted to earn on the conservation investment itself.

Since 1989, five states -- California, New York, Massachusetts, New Hampshire, and Rhode Island -- have initiated reforms to make least-cost investments more profitable for utilities; and in 1989, the National Association of Regulatory Utility Commissioners recommended that states find ways to reward utilities for least-cost investments.[85] There is, however, no consensus on precisely how to meet the regulatory objective of ensuring that the least costly energy supply investment is also the most attractive one from the perspective of a utility's treasurer. It is important to monitor the five states which have initiated reforms to see what works and what doesn't. In the meantime, some of the basic elements of a solution may be emerging. First, the direct linkage of utilities' profits to their sales volumes must be severed. This is achieved, for example, by California's Electric Revenue Adjustment Mechanism, which ensures that if sales volumes diverge from the levels that regulators anticipated when rates were set, rates are adjusted to avoid impact on net revenues. The policy does not guarantee profits or shield income statements from the consequences of wasteful

[85]National Association of Regulatory Utility Commissioners. *Profits and Progress Through Least-Cost Planning*. Washington, D.C., November 1989.

spending. It simply ensures that net earnings authorized by a utility's regulators will not be affected by changes in energy use that those regulators did not expect.

Decoupling profits from sales may be one step toward the successful implementation of least-cost planning in the utility sector,[86] but strategies will also be required that ensure that implementation of a utility's least-cost plan is its most profitable course of action. One step in that direction has been taken by Wisconsin, where companies that elicit large blocks of savings at low cost are allowed to earn bonuses for shareholders.[87] Under reforms in other states, utilities will begin to find cost-effective energy efficiency to be among their most lucrative potential investments. In Rhode Island, Massachusetts, and California, provision is now made for the division of net benefits from cost-effective efficiency programs among shareholders and ratepayers.[88] In general, the best course at the Federal level is *not* to mandate any particular approach, but to encourage the states to experiment with alternative approaches to dealing with a problem that is now widely recognized.[89]

(2) The Search for Truly Competitive Electric-Power Auctions

Auctions increasingly are being used to allocate utility investments among new sources of electricity supply. As of the end of 1989, 27 states had adopted or were developing such competitive procurement systems.[90] These auctions represent a departure from the conventional world in which utilities build their own new capacity and recover their costs from ratepayers. Instead, independent power producers are bidding for the contractual right to meet utilities' needs for power. The winners typically receive long-term contracts entitling them to specified payments for power actually delivered; the contracts, in turn, can serve as vehicles for financing construction of the resources.

Most of the initial bidding ventures have shared two major deficiencies. First, conservation generally has been barred from the competitions. Second, environmental costs have been assigned no weight in the selection process. These deficiencies can be remedied within the context of comprehensive least-cost

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[86]Another important issue which must be resolved is whether conservation investments ought to appear in the utility's rate base or in a monthly fuel adjustment mechanism.

[87]The Commission created a "performance incentive of 1% additional return on capitalized conservation expenditures for each 125 megawatts of load that is saved at a cost of less than $200 per kilowatt plus 2 cents per kilowatt-hour."

[88]Utilities are authorized to keep 10% to 15% of the net savings that remain after program costs are recovered.

[89]For example, Congress could direct state regulators to consider and resolve some of these issues within a specified time. A useful analogy is the 1978 Federal mandate that every state regulatory authority and every non-regulated utility must address six different rate design mechanisms for promoting energy conservation (26 U.S.C. § 2621(d)). The standards had to be considered within two years, with a decision to be adopted no later than one year after the expiration of that period (16 U.S.C. § 2622(b)). The National Energy Policy Act of 1990, introduced by Senator Timothy Wirth, would require state utility commissions to reform rate-making practices to remove disincentives to the use of least-cost planning.

[90]National Independent Energy Producers. *Bidding for Power: The Emergence of Competitive Bidding in Electric Generation*. Washington, D.C., March 1990.

environmental bidding, whereby demand-side alternatives are considered together with supply-side bids, and all bids are adjusted to reflect imputed environmental costs.

Later, we turn to the issue of "environmental costing;" for now, the question remains of how utilities should pay for conservation services provided by consumers or others. In particular, how *much* should utilities be required to pay consumers for demand-side management? At the heart of this question is the issue of how the savings due to increased efficiency should be shared between the utility and its customers. The conceptually correct option is for utilities to pay customers the *difference* between the average costs of electricity to the consumer and the avoided costs to the utility resulting from the increased efficiency. This would correct the inappropriate price signals which exist when electricity rates are based on historical average costs and are below actual marginal costs, thereby encouraging rational energy-conserving decisions by consumers. Demand-side (conservation) programs can thus be designed to equate the marginal cost of conservation to the marginal cost of electricity supply. In this way, the conservation option will be treated equally and efficiently.

Demand-side bids -- conservation investments -- can offer utilities a number of distinct advantages. Conservation programs are flexible means of acquiring energy supplies -- they can accommodate mid-course corrections to account for changing conditions. The relatively short incremental lead time needed to acquire additional resources through conservation programs avoids the need to make large capital investments far ahead of the time when a new resource is expected to be needed, and the small incremental size of each conservation activity permits a closer matching of supply with new demand. Also, conservation opportunities tend to track economic cycles, ensuring that the resource is largest when the need for it is greatest. Finally, costly uncertainties associated with demand forecasting can be restrained by systematically improving energy-efficiencies -- the uncertainty introduced by economic growth projections can be reduced by lowering per-unit consumption.

It is important to recognize that under a variety of circumstances the reliability of demand-reducing alternatives will be *less* than that of supply-augmenting ones. From management's perspective, reduced energy consumption may have a much less certain life (duration) associated with it than new capacity.[91] Furthermore, if demand is reduced too much too fast, the rate of utilization of existing capacity would decrease, and it could be necessary to prorate the fixed cost of capacity across fewer consumed energy units, thus penalizing customers for conservation. If overall demand is not growing, one alternative would be to time demand reductions with retirement of existing capacity.

(3) Internalizing Environmental Costs

Richard Clarke, the CEO of Pacific Gas & Electric Company, has directed his management to "make environmental considerations and concerns part of any decision you make right from the beginning. Don't

[91]Related to this are potential problems associated with monitoring and enforcement. If an "efficiency contractor" promises to cause consumers to reduce fuel consumption by a certain amount, should the utility place as much confidence (value) in this claim as a supply contractor's claim of a certain amount of additional capacity?

think of it as something extra you throw in the pot."[92] Consistent with this call for including environmental concerns in the decision process is the general notion of "environmental costing." Unless the prices of energy alternatives reflect their environmental as well as their direct (internal) costs, true least-cost objectives can not be achieved. The problem in the greenhouse context is that the costs of alternative fuels are typically not affected by their respective emissions of carbon dioxide. One possible approach to this problem would be through the use of CO_2 charges, as examined earlier in this chapter. Such charges may eventually be implemented to comply with future international agreements. In the meantime, a potential approach could be for state and Federal planners and utilities themselves, when comparing alternatives for meeting long-term energy needs, to impute to each energy source a carbon-based penalty that varied with its relative level of CO_2 emissions[93] or more broadly multiple penalties which varied with the environmental costs of some set of emissions, presumably including CO_2 and SO_2.

Despite the soundness of the basic idea of environmental costing, the difficulty of properly designing such systems ought not to be underestimated, as evidenced by the serious flaws found in most of the mechanisms thus far given serious consideration by state regulatory bodies. As outlined above, the damages (of emissions) associated with the combustion of a given fuel constitute the "environmental cost" which ought to be considered when comparing alternative energy options. Yet every state commission which ordered consideration of environmental externality costs through 1990 chose to ignore these (economic) impacts in favor of a "proxy" -- the cost of controlling pollutant emissions. By 1990, 26 utility regulatory commissions had at least initiated formal consideration of including environmental costing in utility planning, bidding, or other resource-selection procedures. Of these, 18 had issued orders or passed legislation requiring utilities to incorporate environmental costing in the planning or bidding process, and in every case, control costs had served as the basis for quantification.[94]

Pollution control costs *cannot* serve as an adequate proxy for pollution damages.[95] Indeed, the costs of controlling a given pollutant do not necessarily bear any direct relation whatsoever to the environmental damage which it causes. Relying upon control costs, instead of true economic measures of environmental damages, as the basis for quantifying "environmental adders" may serve, at worst, to offer less environmental quality, and, at best, to offer environmental protection at far higher costs than necessary. Based upon this flawed evaluation methodology, environmental costing is unlikely to lead to an appropriate mix of electricity-generation sources. Why has there been such a rush to embrace a fundamentally flawed approach? The

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[92]See: Kirkpatrick, David. "Environmentalism: The New Crusade." *Fortune*, volume 121, number 4, pp. 44-55, February 12, 1990.

[93]Care must be taken to ensure that such a program does not replace carbon dioxide emissions with offsetting increments of other greenhouse gases. This is particularly important since CO_2 -- despite representing the largest aggregate impact on global warming -- has a smaller per-unit impact than some of the other greenhouse gases. See: Rodhe, Henning. "A Comparison of the Contribution of Various Gases to the Greenhouse Effect." *Science* 248(1990):1217-1219; and Houghton, Jenkins, and Ephraums, *op. cit.*

[94]See: Cohen, S. D., J. H. Eto, C. A. Goldman, J. Beldock, and G. Crandall. "Environmental Externalities: What State Regulators Are Doing." *The Electricity Journal*, Volume 3, Number 6, July, 1990, pp. 24-35.

[95]Indeed, in those rare circumstances in which incremental damages of pollution might actually be equal to the incremental costs of control, there should be *no* additional penalty placed on the given fuel or source. To do so would worsen, not improve, the situation, i.e., welfare would be reduced since any reduction in emissions would bring greater costs than benefits.

answer seems to be the same as the reply to the old query about why someone is looking for a lost quarter under a lamp post: because it is an easy place to look. Unfortunately, ease of design and implementation are by no means sufficient conditions for effective regulation.[96]

The right way to carry out environmental costing is to evaluate in economic terms the environmental damages of alternative energy options. This is the conceptually correct approach, but the difficulty of making this approach operational should not be underplayed. Substantial uncertainty is associated with all of the available methods of valuing environmental damages. Great advances have been made, however, over the past two decades in the major approaches to estimating the economic damages of pollution: preference-revealing surveys; Hotelling-Clawson-Knetsch methods; hedonic pricing studies; and experimental markets.[97] Indeed, these methods are now used somewhat routinely to produce economic estimates of environmental damages in a variety of contexts, including: Executive Order 12291; the Natural Resource Damage Assessments mandated by CERCLA (the Superfund law); and environmental litigation, as in the Exxon Valdez case.

Thoughtful application of these methods of evaluating the damages of pollution can produce appropriate environmental costing.[98] EPA and other agencies of the Federal government could be of great assistance in this regard by helping states and their utility commissions begin to develop correct procedures for evaluating the environmental costs of alternative energy options (on both the supply side and the demand side).[99]

Addressing Equity Concerns

Increased use of comprehensive environmental least-cost bidding would likely bring significant benefits to society as a whole, but could conceivably have negative consequences for some segments of the population. By moving towards pricing mechanisms which more closely reflect the true marginal costs of

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[96]See: Krupnick, Alan. "The Environmental Costs of Energy Supply: A Framework for Estimation." Unpublished manuscript, Resources for the Future, Washington, D.C., December 1989.

[97]There are three principal methodologies for evaluating the benefits (the avoided damages) of environmental protection. One approach is the preference-revealing survey, usually referred to as the contingent valuation method. The second principal approach is inference from actual market behavior; this includes two distinct methods: the Hotelling-Clawson-Knetsch (or travel cost) method and hedonic pricing studies. The third principal approach is the use of experimental markets. See: Mitchell, Robert Cameron and Richard T. Carson. *Using Surveys to Value Public Goods: The Contingent Valuation Method*. Washington, D.C.: Resources for the Future, 1989; and Freeman, A. Myrick III. *"Methods for Assessing the Benefits of Environmental Programs." Handbook of Natural Resource and Energy Economics, Volume I*, eds. Allen V. Kneese and James L. Sweeney, pp. 223-266. Amsterdam: North Holland, 1985.

[98]The U.S. Department of Energy is currently sponsoring an effort to develop environmental (and energy-security) external cost estimates, in cooperation with Oak Ridge National Laboratory and Resources for the Future. A similar effort is ongoing in New York State, where a model is being developed for potential use by electrical utilities to estimate environmental costs of alternative energy sources. For further discussion of how to carry out correct environmental costing, see: Krupnick 1989, *op. cit.*

[99]A step in the right direction was made in the new Clean Air Act amendments, which require the Federal Energy Regulatory Commission, in consultation with EPA, to develop models for incorporating net environmental benefits into the regulatory treatment of renewable energy.

energy (including environmental costs), better long-term decisions will be made by both producers and consumers. Practically speaking, however, another likely outcome would be higher electricity prices, as a result of the induced shift away from relatively dirty to cleaner energy sources. Two groups likely to be affected by these changes are low-income households and those who work for, hold stock in, or otherwise benefit from "dirty" electricity production.

To the extent that electricity is vital to the well being of all members of society, an increase in energy prices to low-income households may be undesirable. One component of policy design, therefore, may be utility pricing schedules which allow for initial increments of energy consumption to be very low priced (via so-called "lifeline rates"). In this way, the ability of low-income households to meet essential needs would not be compromised.

How we should feel about those currently benefitting from dirty energy providers is less obvious. Beyond ordinary unemployment compensation, society generally makes no special effort to ease the burden of those who lose their jobs because of private market forces -- that is, because tastes change or because new technologies render some products obsolete. Why, then, should special provisions be made for those who suffer when society decides to fix an environmental problem (internalize an external cost)? If one power supplier becomes more competitive as a result of moving to environmental costing, some other supplier will suffer the opposite fate. If they are located near one another, it might be possible for new jobs created at one source to be filled by those displaced from the other source. However, electric power is sometimes imported from afar, and new jobs may not open up close to where existing jobs disappear. In these cases, it will be necessary for policy makers to consider means of compensation such as job-search assistance, retraining, and possible relocation assistance.

THREE LEVELS OF POLICY INSTRUMENTS FOR GLOBAL CLIMATE CHANGE

It is unlikely that scientists will be able to predict the timing and precise impacts of global climate change anytime soon, but the call for action from some quarters is unmistakable. If governments decide that action is indeed warranted, important policy questions will have to be addressed, possibly quite quickly. Given the pervasive role in virtually all national economies of energy generated from fossil fuels, policies designed to address global climate change could have profound effects on many aspects of our lives. Therefore, at both the international and domestic levels, cost effectiveness must be a central consideration in policy design, to ensure that the economic well-being of millions of persons around the world is not unduly compromised.

At the international level, a system of tradeable greenhouse gas permits can address simultaneously the issues of cost effectiveness *and* equity. As a global problem involving uniformly-mixed pollutants, global warming is particularly well-suited to such an approach that controls CO_2 (and perhaps other greenhouse gas) emissions at the aggregate level, while it encourages individual nations with the lowest costs of control to take on added responsibility. Through the initial allocation of permits, questions of fairness between industrialized and developing nations can be addressed directly, and a north-south technology transfer can thus be engendered. A key concern in implementing a greenhouse policy -- whether or not it involves tradeable permits -- will be ensuring that compliance is adequately monitored and enforced.

While tradeable permits may be the most cost-effective and practical instrument for controlling carbon dioxide emissions at the international level (and could conceivably be used domestically as well),

carbon charges may be a more practical mechanism for reaching domestic emissions objectives (subsequent to international negotiations of targets and possible reallocation through tradeable permits). While either a carbon or BTU charge could be used to achieve national CO_2 objectives, it is important to recognize that the stakes for setting the charge will be high, since each increment of control will carry significant burdens on the economy. One way to mitigate the effect of these charges on the competitiveness of industry would be to offset the charges with reductions in distortionary taxes.

Even if international agreement is not forthcoming, there may be some actions which the U.S. could reasonably consider adopting on a unilateral basis. For example, certain policies to encourage increased energy efficiency could have positive net benefits, regardless of their implications for global climate change. One such cost-effective inducement for increased energy efficiency would be greater use of comprehensive environmental least-cost utility planning and bidding. In particular, auctions for new power sources could allow for bids based upon demand-side reductions and could incorporate environmental impacts into total cost estimates. Such systems would move us closer to the point at which energy generation and use decisions are made in the context of overall current and future societal impacts.

CHAPTER 3
SOLID AND HAZARDOUS WASTE MANAGEMENT

As the decade of the 1990's begins, it has become increasingly clear that we must address the serious problems caused by the massive quantities of industrial and household waste our society generates. These problems include, among others: shortages of capacity of landfills and other conventional means of disposing of municipal solid waste; human exposure to toxic substances found in hazardous and industrial solid waste; and ecological impacts from improper hazardous waste disposal. Clearly, waste management is not a single policy problem, but a label for a broad range of environmental challenges. Hence, an equally diverse set of policy mechanisms may be required to address this set of challenges.

In order to assemble a portfolio of waste management policies, it is first necessary to identify the precise problems which need to be addressed. We therefore begin this chapter with a brief examination of major waste management problems and a review of previous policy responses. Then, we investigate a variety of ways of supplementing current policies with improved use of economic-incentive mechanisms which can be brought to bear upon problems associated with non-hazardous waste, hazardous waste, or both. First we examine improved price signals for solid waste management -- unit pricing of municipal solid waste collection and disposal; retail disposal charges; and virgin material charges. Next, for those situations where increased recycling can be an effective means to achieving legitimate waste management goals, we consider an approach which uses the forces of the market place to encourage recycling at lower costs than would otherwise be incurred -- recycled-content standards combined with tradeable permits. We also consider a market mechanism which is particularly promising for waste management problems associated with littering and other illegal disposal problems -- deposit-refund systems. We review the use of such systems in so-called "bottle bills," and investigate their potential application to other components of the waste stream.

All of these incentive-based instruments can encourage source reduction of generated waste, an important element of any portfolio of waste management policies. It must also be recognized, however, that a major component of both hazardous and conventional waste problems is the dwindling number of available sites for ultimate disposal. Even with the most ambitious of source-reduction programs, new facilities for proper disposal of municipal solid waste and hazardous waste will be required, but the infamous NIMBY -- "Not-In-My-Backyard" -- problem seems to plague virtually every public or private effort to establish a new disposal facility. In the final section of the chapter, we examine one potential approach to the NIMBY problem which could help to break the logjam on the siting of new waste disposal facilities.

WASTE MANAGEMENT PROBLEMS

Municipal Solid Waste

Over the past decade, the increasing volume of solid waste generated by municipalities has emerged as a pressing problem in many parts of the U.S. While designated landfill space is running out in some areas,[100] many communities have effectively blocked the construction of new facilities. With landfill capacity on the decline, some communities have turned to incineration, but concerns exist that garbage burning contributes to air pollution problems and generates ash which must itself be disposed of safely.[101] These developments have led to a solid-waste capacity problem of "crisis" proportions in some parts of the country.

The municipal solid waste stream is affected by the complex process by which potential wastes move from raw materials to reuse, recovery, or disposal.[102] The size and composition of the stream is shaped by decisions of manufacturers, consumers, waste processors, and municipalities. All of these decisions are affected -- to varying degrees -- by price signals. Manufacturers' raw-material and product-design choices -- reflecting consumer preferences for products and packaging as well as the availability and cost of materials -- influence the quantities and types of materials employed. Consumers influence the waste stream both through their purchasing decisions and through their choices regarding disposal.

The vast majority of wastes in the U.S. end their course in a landfill. In 1988, the country landfilled 73% of its municipal solid waste, incinerated 14%, and recycled 13%.[103] Despite this overall reliance upon landfilling, there is great regional variation due to population density, the cost and availability of land for waste disposal, hydrogeologic and geographic conditions, social attitudes toward the environment, economic characteristics, and municipal solid waste policies. Landfill capacity problems are most acute in the

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[100]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.

[101]For a recent technical investigation of incineration technologies, see: Yakowitz, Harvey. "Incineration of Municipal Solid Waste: Scientific and Technical Evaluation of the State-of-the-Art by an Expert Panel." *Resources, Conservation, and Recycling* 4(1990):241-252.

[102]See: U.S. Congress, Office of Technology Assessment. *Facing America's Trash: What Next for Municipal Solid Waste*, OTA-O-424. Washington, D.C.: U.S. Government Printing Office, October 1989.

[103]See: Franklin Associates, Ltd. *Characterization of Municipal Solid Waste in the United States: 1990 Update*. Report prepared for the U.S. Environmental Protection Agency, Washington, D.C., June 1990.

Northeast, where tipping fees (disposal charges) are as high as $125 per ton. The Northeast has turned increasingly to incineration, with Connecticut leading the way by incinerating 66% of its municipal solid waste. By contrast, landfill tipping fees in the West are typically less than $30 per ton and as low as $5 per ton in some communities.

It has been estimated that between 1970 and 1988, the total quantity of disposed (landfilled and incinerated) municipal solid waste grew more than 37%, with discards per capita growing by 14% (Table 3-1).

Table 3-1: The Municipal Solid Waste Stream

Materials Discarded	1970		1988	
	Million Tons	Share	Million Tons	Share
Paper and Paperboard	36.8	32.4%	53.4	34.2%
Glass	12.5	11.0%	11.0	7.1%
Metals	13.7	12.1%	13.1	8.4%
Plastics	3.1	2.7%	14.3	9.1%
Rubber and Leather	2.9	2.6%	4.4	2.9%
Textiles	2.0	1.8%	3.8	2.5%
Wood	4.0	3.5%	6.5	4.2%
Food Wastes	12.8	11.3%	13.2	8.5%
Yard Wastes	23.2	20.5%	31.1	20.0%
Miscellaneous Inorganics	1.8	1.6%	2.7	1.7%
Other	0.5	0.4%	2.4	1.6%
TOTAL	113.3	100.0%	156.0	100.0%

Source: Franklin Associates, Ltd. *Characterization of Municipal Solid Waste in the United States: 1990 Update*. Prepared for the U.S. Environmental Protection Agency, Washington, D.C., June 1990.

A few materials -- principally aluminum, high-grade paper, and certain plastics -- have significant salvage values, and some wastes -- particularly plastics, rubber, textiles, wood, and paper products -- have high energy contents which can be recovered through incineration.[104] Although most municipal waste is not toxic,

[104]Modern incineration technologies reduce the volume of waste by 60% to 90% and can generate industrial steam, electricity, or fuel. The efficiency of the generation process and the consequent environmental effects depend upon completeness of combustion and toxicity of the waste stream.

hazardous household materials -- batteries, inks, used oils, antifreeze, paints and paint solvents, insecticides, and herbicides -- often find their way into the municipal solid waste stream.

Given the environmental and direct, private costs of disposing of solid waste by traditional means, it is important to provide appropriate incentives for those who generate and manage the waste stream to economize in their use of materials, make better use of wastes that are generated, and dispose of the remaining wastes in environmentally benign ways. But for most Americans, there has been little incentive to reduce the amount of solid waste they generate or to recycle what they do generate. The cost of throwing away an additional item of refuse has been (and in most places continues to be) zero. In these communities, residents need merely place their empty bottles, cans, lawn clippings, and old newspapers in a trash chute or at the curbside. Such refuse then "disappears" when the municipality (or its contractor) picks it up. Although the costs of refuse removal and disposal are significant, these services are typically borne by consumers only *indirectly* by way of a fixed disposal charge or an annual property tax assessment. Hence, disposal costs borne by consumers are *not* related to the quantity (or toxicity) of waste they throw away. Given the largely hidden cost of municipal solid waste disposal in the United States, it is thus not difficult to understand why the "throw-away ethic" thrives.

Hazardous Waste

The sources of toxic substances released into the environment are both numerous and diverse: every day each of us uses a variety of products and services which generate hazardous wastes (in their manufacture or use). It is important -- but difficult -- to develop a sense of the size of the problem.[105] Most estimates place total annual hazardous-waste generation at between 250 and 500 million tons (Table 3-2).[106] Such estimates imply that, on average, upwards of *one ton of hazardous waste per person* is generated each year in the U.S. Viewing sources by industrial sector, the largest generators appear to be the chemical, metals, and petroleum industries.[107] Another perspective on the size of the problem is provided by examining the scope and cost associated with various regulations aimed primarily at cleaning up or maintaining disposal sites. Not all sites are alike, either in terms of risk or expected cleanup costs, but the best available estimates indicate that the overall problem may be enormous -- with aggregate national cleanup costs expected to be in the range of $300 to $750 billion by the year 2000.[108]

[105]This part of the chapter draws, in part, upon a paper prepared for Project 88/Round II by Robert W. Hahn, "Rethinking Hazardous Waste Management Policy."

[106]See: McCarthy, James and Mark Reisch. *Hazardous Waste Fact Book*. Environment and Natural Resources Policy Division, Congressional Research Service, 87-56 ENR, June 30, 1987; U.S. Office of Technology Assessment. *Technologies and Management Strategies for Hazardous Waste Control*. Summary, OTA-M-197, Washington, D.C., March, 1983. Using a broader definition, the U.S. annually generates about 1.3 billion tons of waste that legally qualifies as hazardous, 75% of it managed under the Clean Water Act, rather than under the various components of the hazardous waste regulatory system.

[107]See: U.S. Congressional Budget Office. *Hazardous Waste Management: Recent Changes and Policy Alternatives*. Washington, D.C., May 1985.

[108]See: U.S. Office of Technology Assessment 1987, *op. cit.*

Table 3-2: National Generation of Industrial Hazardous Wastes, 1983

Waste Type	Estimated Quantity (thousand tons)	Share of Total
Nonmetallic Inorganics	131,442	50%
Metal-Containing Liquids	19,760	7%
Miscellaneous Wastes	15,415	6%
Metal-Containing Sludge	14,497	6%
Waste Oils	14,249	5%
Nonhalogenated Solvents	12,130	5%
Halogenated Organic Solids	9,784	4%
Metallic Dusts and Shavings	7,733	3%
Cyanide and Metal Liquids	7,383	3%
Contaminated Clay, Soil, and Sand	5,461	2%
Nonhalogenated Organic Solids	4,578	2%
Dye and Paint Sludge	4,236	2%
Resins, Latex, and Monomers	4,018	2%
Oily Sludge	3,734	1%
Halogenated Solvents	3,479	1%
Other Organic Liquids	3,435	1%
Explosives	720	<1%
Halogenated Organic Sludge	715	<1%
Cyanide and Metal Sludge	557	<1%
Pesticides, Herbicides	26	<1%
Polychlorinated Biphenols	1	<1%
TOTAL	265,595	100%

Source: U.S. Congressional Budget Office. *Hazardous Waste Management: Recent Changes and Policy Alternatives*. Washington, D.C.: U.S. Government Printing Office, 1985.

Such staggering costs suggest that it is important to focus attention on those problems (or sites) which pose the greatest risk, and to consider the risks and costs of various remediation and waste-reduction strategies. It is well known that the primary dangers of land-based disposal of hazardous waste are associated with the contamination of drinking water, but the magnitude of these risks is highly uncertain. Overall, the aggregate *relative* risks from hazardous waste at active and inactive sites are surprisingly low, *compared* with risks posed by other environmental threats. A major EPA report found that active and inactive hazardous-waste sites rank 13th and 8th, respectively,

as environmental sources of cancer risk (in a ranking of 26 environmental concerns).[109] In general, EPA concluded that hazardous-waste sites are not among the most critical environmental threats faced by the country.[110] A recent EPA Science Advisory Board study has confirmed these findings.[111]

THE POLICY RESPONSE TO WASTE MANAGEMENT PROBLEMS

State and particularly local governments have traditionally had primary responsibility for regulating or managing the collection and disposal of municipal and industrial solid waste. These same levels of government have also been active in the regulation of storage and disposal of various kinds of hazardous waste. Later in the chapter, we return to the current and potential roles of state and local governments in our discussion of incentive-based policy mechanisms. But for now -- in keeping with the overall focus of this report -- we briefly review the Federal policy response to waste management problems.

Federal Policy for Solid Waste Management

The Federal government has played a role in non-hazardous waste regulation since the mid-1960's, when the Solid Waste Disposal Act of 1965 first provided Federal funds for research and planning and gave Federal agencies advisory authority over local solid waste regulation. The Resource Conservation and Recovery Act (RCRA) of 1976 and its amendments of 1984 significantly increased EPA's role in solid waste regulation, most importantly by requiring EPA to issue regulations regarding solid-waste landfill design, construction, and operating standards.[112] EPA also has regulatory authority over incinerator air emissions through the Clean Air Act and incinerator ash through RCRA. In the mid-1970's, Congress enacted provisions within RCRA and elsewhere to encourage recycling, but these provisions, including the development of government procurement guidelines to promote purchasing of recycled materials, have yet to be fully implemented.

Although late in responding to the solid waste "crisis," many states and municipalities and, to a lesser degree, the Federal government, have recently taken action. In 1990, members of Congress introduced more than 75 bills dealing with solid waste management, and EPA announced a national goal of reducing the solid waste stream by 25% by 1992 and by 50% by 1997 via recycling and source reduction. Many states have

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[109]In terms of non-cancer, human-health risk, active and inactive toxic sites ranked in the lowest category (3rd of 3 ranks); in the case of ecological risk, the rankings were sixth and fifth, respectively (out of a total of six ranks). Finally, for (economic) welfare effects, EPA's rankings placed active and inactive hazardous waste sites at eleventh and ninth, respectively (out of 23 ranks).

[110]See: U.S. Environmental Protection Agency. *Unfinished Business: A Comparative Assessment of Environmental Problems*. Overview Report, Office of Policy Analysis, Washington, D.C., February, 1987.

[111]U.S. Environmental Protection Agency, Science Advisory Board. *Reducing Risk: Setting Priorities and Strategies for Environmental Protection*. Washington, D.C., September 1990.

[112]See: Hall, Ridgway M. and Nancy S. Bryson. "Resource Conservation and Recovery Act." *Environmental Law Handbook*, pp. 61-107. Rockville, Maryland: Government Institutes, Inc., 1985. In 1988, EPA proposed such regulations, but has not yet issued them in final form.

issued directives calling for even greater reductions. Moreover, states and localities have adopted a variety of strategies intended to limit waste and increase recycling, including: mandatory separation by households of one or more categories of solid waste; prohibitions on the disposal of specific items in landfills; and bans on packaging and products.[113] In addition, nine states have enacted deposit-refund systems for beverage containers.

Although these policies respond to some of the *symptoms* of the solid waste "crisis," they do not systematically address its *causes*, since they fail to remedy the distorted incentives that underlie problematic consumer and manufacturer behavior. In some cases, new policies actually exacerbate the problems. For example, while some consumers may favor products packaged in recyclable material, a requirement that consumers separate glass containers can encourage consumers to purchase more products packaged in other materials which may have higher social disposal costs, in order to avoid the separation requirement. Moreover, mandatory separation has not always led to substantially increased recycling. Without adequate recycling capacity and markets for recycled materials, many communities that implemented mandatory separation requirements initially had to store or even landfill separated newsprint.[114] In other cases, the use of ad hoc adjustments to an inherently flawed system may create new distortions. For example, bans on certain types of packaging or products (such as disposable diapers) prevent consumers with strong preferences for such packaging or products from obtaining them, without having a significant effect on the waste stream.

Existing deposit-refund systems encourage separation of beverage containers through price incentives, but -- depending on their design -- they can fail to provide the right incentives for purchasing and disposal.[115] By charging the same amount for glass, metal, and plastic containers, such laws do not encourage consumers to choose the container with the lowest social disposal cost; and by requiring consumers to deliver separated containers to redemption centers, deposit-refund laws can use up more resources (in the form of energy and processing costs) than they save.

Federal Hazardous Waste Policy

Federal hazardous waste management policies[116] have evolved over three decades, with their central focus being on the reduction of emissions of various substances to specific media, such as air, land, or water. Toxic substances are released into the environment as gases, liquids, sludges, and solids, but not necessarily along pathways which individual statutes or regulations address. Hence, environmental laws with single media foci, such as the Clean Air and Clean Water Acts, have sometimes done little more than transfer toxics among media: wastewater treatment facilities and some air pollution control devices produce sludges which

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[113]The results of a national survey of state recycling policies are provided by: Thurner, Christian and Dayna Ashley. *Developing Recycling Markets and Industries*. Washington, D.C.: National Conference of State Legislators, July 1990.

[114]See: "Paper Recycling: For Now, Too Much of a Good Thing." *New York Times*, September 6, 1989, page A19.

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

[116]Our focus is much broader than a legal definition of "hazardous waste" (under RCRA Subtitle C, as implemented) would imply.

may be considered hazardous under RCRA; likewise, surface impoundments of toxic substances regulated under RCRA may produce air emissions -- volatile organic compounds -- a target of the Clean Air Act.

Two major Federal laws regulate the management of hazardous wastes. RCRA, passed in 1976, was designed to govern the transport, treatment, and disposal of currently generated wastes, and the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) of 1980, more commonly known as "Superfund," was intended to clean up abandoned disposal sites thought to present significant risks.[117]

RCRA addresses the management of hazardous waste in a variety of ways. It requires EPA to define hazardous wastes, either through listing or through defining characteristics. Also part of RCRA is a "cradle-to-grave" tracking system intended to discourage "midnight (illegal) dumping" by keeping close tabs on the location of hazardous waste in the system and by creating records of generation and disposal. Generators must identify hazardous waste and prepare a "manifest" to accompany the waste from generation to ultimate disposal. They must also identify an authorized transporter and disposal site that will accept the waste. Transporters and disposers are not allowed to accept waste that does not have an appropriate manifest.[118] In 1984, RCRA was amended by the Hazardous and Solid Waste Amendments (HSWA), which placed further restrictions on the disposal of hazardous wastes on land,[119] imposed tight deadlines and identified specific chemical constituents to be regulated, and broadened the scope of regulations to include "small-quantity generators" (ones that produce between 100 and 1,000 kilograms per month).

In contrast to RCRA, which deals with existing waste generators and sites, Superfund focuses on abandoned hazardous waste sites and accidental releases. The Superfund law (CERCLA) contains several elements, including: responsibility for cleanups; designation of cleanup sites; and financing of the program. Cleanups are supposed to be paid for by "responsible parties." The statute imposed a standard of strict, joint, and several liability, meaning that almost anyone connected with a Superfund site could be asked to pay for part or all of a cleanup, but identifying responsible parties and getting them to pay can be extremely difficult.

Superfund was intended to identify and remedy those hazardous waste sites in greatest need. To this end, EPA established a National Priorities List (NPL), and to help finance government activities and hasten

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[117]For analyses of RCRA and CERCLA, 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; and Dower, Roger C. "Hazardous Wastes." *Public Policies for Environmental Protection*, ed. Paul R. Portney, pp. 151-194. Washington, D.C.: Resources for the Future, 1990.

[118]The effectiveness of the manifest system has been limited. It only tracks that fraction of hazardous wastes that are managed off-site, less than 5% of the estimated total, and there have been problems in implementing the tracking system. Additionally, the program significantly increases the cost of legal disposal relative to illegal dumping, thus providing an unintentional incentive for increases to the latter. On the other hand, there is at least anecdotal evidence that midnight dumping has decreased since RCRA's enactment, partly due to the (again unintentional) incentive for source reduction which the manifest system's paper burden places on firms. See: U.S. Congressional Research Service. *Hazardous Waste Fact Book*. Environment and Natural Resources Policy Division, Washington, D.C., June 30, 1987; and U.S. General Accounting Office. *Illegal Disposal of Hazardous Waste: Difficult to Detect or Deter*. GAO/RCED-85-2, Washington, D.C., 1985.

[119]More than 1,000 land disposal facilities may have closed as a result. Approximately 2,000 facilities closed between 1980 and 1987, with very few new facilities opening.

cleanup efforts, the Congress set up the Hazardous Substance Response Fund, which was allocated $1.6 billion over five years. The Superfund Amendment and Reauthorization Act of 1986 (SARA) significantly expanded the Superfund program by providing for: a five-fold increase in the budget to $8.5 billion over 5 years;[120] a timetable for cleaning up over 300 sites; a preference for "permanent" remedies; expansion of tools available to the government for obtaining settlements from potentially responsible parties; and "right-to-know" provisions, which require firms to submit data on their actual emissions to EPA.

New Policies for Waste Management

As we noted above, waste management is not a single policy problem, but a convenient label for a wide range of problems. In most cases, the problem is insufficient capacity at landfills or incinerators to deal with the volume of municipal solid waste which is produced. In such cases, much can be accomplished by adopting systems which provide better price signals in the form of unit pricing of municipal solid waste collection or disposal. But in some specific cases, such as where ground water contamination is of central concern, problems may remain even in the presence of unit pricing reforms. In this context, retail disposal charges or virgin materials charges may be appropriate.

In some cases, increased recycling of specific commodities or products may be especially desirable. In such situations, recycling targets may be achieved at lower aggregate cost than otherwise by combining recycled-content standards with tradeable permit systems. In other cases, however, our concern may center on reducing littering and other forms of illegal disposal (of specific products); in this case, deposit-refund systems stand out as a particularly promising approach. In the following sections, we examine each of these incentive-based approaches to waste-management problems.

BETTER PRICE SIGNALS FOR SOLID WASTE MANAGEMENT

At the core of most municipal solid waste problems are flawed price signals which fail to bring to the attention of consumers and producers the real costs of the wastes they generate. Typically, individuals are not even aware of the costs of waste collection and disposal, since in most communities, these costs are imbedded in property or other taxes. Some municipalities have made the costs of waste disposal more apparent to consumers by labelling a separate charge for waste collection in their semi-annual property tax assessments. But this has little or no effect, since charges are usually levied as flat fees that do not vary with the quantity of waste generated. In other words, the incremental cost to the individual of generating an additional unit of solid waste for collection and disposal is zero. Since charges for waste collection are the same no matter what quantity of trash individuals generate, no incentive exists for persons to modify their behavior in regard to their purchasing and disposal decisions. Imagine what kinds of cars we would buy and how much we would drive if our total annual bill for gasoline was *independent* of the quantity of gasoline we used. This is precisely what is happening today with municipal solid waste management in most communities of the U.S.

These flawed price signals affect the way products are produced, since consumers continue to demand products without concern for disposal costs. Likewise, the mix of recycling and disposal technologies

[120]This was funded primarily by petroleum and chemical feedstock taxes plus broad-based taxes on business.

employed by communities can be distorted by poor price signals, and in some cases, recycling, for example, may be under-utilized (or over-utilized), relative to landfilling or incineration.[121]

Fundamental to an effective waste management strategy is the removal of these distortions by getting the prices right. Decisions by consumers and firms should reflect the incremental costs of waste disposal. At least three incentive-based approaches hold promise for accomplishing this, each focusing on a different point in the product life cycle: (1) curbside waste collection charges, which primarily address the issue at the point of disposal; (2) retail disposal charges, which focus on the point of sale; and (3) virgin material charges, which target the point of production. Local conditions and policy objectives will determine which instrument is most appropriate, but unit pricing of municipal solid waste collection/disposal typically ought to be considered as the first line of attack.[122]

Unit Pricing for Municipal Solid Waste Collection/Disposal

By charging households for waste collection services in proportion to the amount of refuse they leave at the curbside, unit pricing can tie household charges to the real costs of collection and disposal.[123] In this way, it creates strong incentives for households to reduce the quantities of waste they generate,[124] whether through changes in their purchasing patterns, reuse of products and containers, or composting of yard wastes.[125] Furthermore, by placing differential unit charges on unseparated refuse and specified, separated recyclables, these charge systems can create incentives for households to separate the recyclable components of their trash.

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[121]Due to tremendous differences among communities in their land-use patterns, population densities, transportation systems, industrial bases, natural resources, hydrogeology, and air flow patterns, there is certainly no single correct disposal technology or mix of technologies for all communities. Landfilling may be a more appropriate disposal option for some waste in many parts of the West, for example, while being prohibitively expensive in many parts of the East, where land availability and groundwater conditions are less favorable.

[122]This part of the chapter draws, in part, upon a paper prepared for Project 88/Round II by Peter S. Menell, "Using Economic Incentives to Regulate the Municipal Solid Waste Stream."

[123]See: Goddard, Haynes C. "Economic Incentives for Managing Household Solid Waste: Upstream Versus Downstream Policies." Paper presented at Conference on Research Developments for Improving Solid Waste Management, sponsored by the Air and Waste Management Association and the U.S. Environmental Protection Agency, Cincinnati, Ohio, February 4, 1991; and Goddard, Haynes. *Managing Solid Waste: Economics, Technology, Institutions.* New York: Praeger, 1975.

[124]It is important to note that a volume-based unit-charge collection system can provide strong incentives for households to use trash compactors (or less sophisticated methods) to reduce the volume which their trash occupies. Whether or not this is desirable will depend upon local circumstances, including the costs of centralized compaction, labor costs, and costs of household compactors, and household opportunity costs of time.

[125]Yard wastes account for about 20% of municipal solid waste on average (and an even larger percentage in suburban communities where curbside charges are most feasible), but it should be recognized that improper composting can lead to its own set of environmental problems, since yard wastes contaminated with pesticides can theoretically leach into shallow aquifers.

Thus, 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.[126] While encouraging both groups to contribute to reductions in the solid waste flow, unit pricing provides flexibility to consumers and producers in making their consumption and production decisions. Because of this, unit pricing shares an attribute of all incentive-based mechanisms -- by allowing flexibility in how goals are met, it provides important stimuli for research, development, and adoption of improved technologies.

The design and ultimate implementation of curbside charges must be undertaken at the local level, but an important role can be played in this process by the Federal government. At the very least, EPA can become a clearinghouse of information and thus can assure that individual experiences are properly documented and made available to other communities. Additionally, it is possible that the Federal government could play a substantially more aggressive role in facilitating local consideration of unit pricing of municipal solid waste collection, perhaps in a way analogous to the role it plays in the case of (state and local) electricity pricing under the Public Utilities and Regulatory Policy Act.

If municipalities are to move toward greater reliance on unit pricing for collection and disposal services, it is important that careful consideration be given to a number of important design and implementation issues. In some of the initial forays into unit pricing, a number of communities, including Seattle, Washington, have introduced curbside charges by billing households for the number and size of trash receptacles they use.[127] In the Seattle system, 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.[128] The program appears to be having the intended effect of substantially reducing the total flow of solid waste into the city's landfills,[129] but concerns about equity naturally arise, since it is possible that low-income households would pay greater shares of their income for pick-up services than would higher-income

[126]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.

[127]See: Skumatz, Lisa A. "Variable Rates: Using Your Rate Structure to Encourage Waste Reduction and Recycling." Presentation to GRCDA Conference. February 14, 1990.

[128]The complete monthly price schedule is: $10.70/19-gallon container; $13.75/32-gallon container; $22.75/60-gallon container; and $31.75/90-gallon container. These charges are made bi-monthly and are for curb or alley pick up; backyard service costs 40% more. Yard waste is picked up for a separate $2/month charge. See: Seattle Solid Waste Utility. *Seattle Solid Waste Utility Rate Sheet and Customer Reply Card*. Seattle, Washington, 1988.

[129]Ten years ago, the average single-family household was setting out 3.5 30-gallon containers per week. By 1988, about 60% of participating households subscribed for one 32-gallon container or less, and by 1989, this number had risen to 87%. See: Seattle Solid Waste Utility, Public Information Department. *Municipal Solid Waste Management Program Description*. Seattle, Washington, 1991. Furthermore, analysis of Tacoma, Washington's experience with a similar system indicates that a 10% increase in price of 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.

households.[130] The Seattle system addresses this issue much as electrical utilities do with low "life-line rates" for initial blocks of power usage -- in Seattle, only the fixed cost of curbside pick-up are charged to customers for their first 32-gallon container.[131]

Per-can pricing is a step in the right direction, but it can be problematic. Customers are charged for a full can even if it is only partially filled. Furthermore, under programs where customers register in advance for the number of cans they will use, they are charged even if they do not use a can at all in a particular week. "Bag-and-tag" systems avoid the problems inherent in the simplest per-can approach, and keep "metering" and billing costs down. Under such systems, households can dispose of unseparated refuse only in specially designated trash bags sold by the municipality. A corollary approach involves the sale of stickers which are placed on cans or bags of specified dimensions. The former approach has been adopted in Perkasie, Pennsylvania. Unlike Seattle, where customers are registered for a specific number of cans per week, households in Perkasie choose how many bags to use each week. The total amount of unseparated solid waste collected in Perkasie fell by 60% in the program's first year of operation, and total collection and disposal costs decreased by 40%.[132]

While metering and billing costs for bag-and-tag systems can be kept very low, a reasonable concern is the possibility of increases in illegal dumping. The experiences of Seattle, Perkasie, and other communities suggest, however, that this need not be a problem if systems are properly designed.[133] New programs can be introduced incrementally, with charges rising gradually until they equal the true marginal costs of disposal. Also, municipalities can provide for free or very low-cost disposal at transfer stations, thus removing some of the incentive to dump waste illegally. Furthermore, stiff penalties for illegal disposal are important. As a result of such approaches, Seattle has found that the costs of cleaning up illegally dumped waste are relatively small -- less than 1% of total system costs.

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[130]The correct comparison is between the relative effectiveness of a unit pricing system and the current payment system. Studies which have compared unit charges with property taxes have generally found unit pricing to be somewhat *less* regressive, although there is substantial variation among communities. 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 also 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 reinforce the effect described above, namely to reduce the regressivity of the system.

[131]In any event, it may be argued that unit charges allocate costs of waste disposal more equitably than conventional approaches, since charges are proportional to waste generation.

[132]The fact that total collection and disposal costs decreased is important, since part of the dramatic reduction in the collection of *unseparated* waste represents a shift to separated waste. See: Paul, Bill. "Pollution Solution: Pennsylvania Town Finds Way to Get Locals to Recycle Trash." *Wall Street Journal*, June 2, 1989, page 1; and Gottlieb, Robert and Sidney Wolf. *Solid Waste Management: Planning Issues and Opportunities*. American Planning Association, Planning Advisory Service Report Number 424/425, Chicago, Illinois, September 1990.

[133]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; and Skumatz and Breckinridge 1990, *op. cit.*

Unit pricing has obvious limitations in the case of those multi-unit dwellings where residents can dispose of their waste anonymously, thus free riding on the charges paid by others.[134] In such situations, unit charges at the building level can at least provide incentives to landlords or condominium managers to encourage residents to conserve on their waste generation. Thus, unit charges can ensure, at least in the aggregate, that waste generated will bear the cost of its disposal.

A number of communities have combined unit charges for unseparated refuse with curbside collection of recyclable materials.[135] This lowers the direct cost of recycling to consumers and gives them additional control over their waste charges. Such a program was launched by Perkasie at the same time as its unit pricing system; recycling increased by 150% in the first year of operation. Some communities provide curbside recyclable collection services free of charge, but this is by no means necessarily desirable. The rate for collecting recyclable materials should theoretically be set equal to the cost of transportation and program administration less the value of recyclable materials (whether positive or negative).[136] On the other hand, charging less for some recyclables or providing refunds at the curbside dramatically raises administrative costs, relative to a system of charging for mixed refuse combined with free pick-up for some recyclables. This combination can provide strong incentives for separation without significantly increasing administrative costs.[137] Municipalities should carefully choose what, if anything, they will pick up for free.

Whether or not special provision is made for separated recyclables, accurate unit pricing of collection and disposal of municipal solid waste provides a promising approach to addressing what has become an increasingly pressing problem. Unit pricing can provide signals to waste generators that appropriate levels of source reduction ought to be included in their waste-management decisions. By providing a high degree of choice to consumers and firms, this approach combines cost-effectiveness with a minimum amount of inconvenience to those affected.

Retail Disposal Charges

Although in most cases unit charges should be considered as the front-line attack on solid-waste management problems, there are some specific situations in which it could be desirable to improve price signals at the point of purchase of products, instead of at the point of disposal. A mechanism which could accomplish this, in theory, is a retail disposal charge, by which communities place surcharges on the sale of items to reflect the costs of disposal of products and packaging. There are two principal situations in which

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[134]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 costs 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.

[135]Many communities also provide for the collection of yard compost at a different rate. Seattle even provides composting bins to customers free of charge.

[136]Some separated wastes have a negative value. Using "avoided cost" pricing, communities should be willing to pay recyclers to take the materials as long as the price is less than the price of landfilling or incinerating the items. The collection price to consumers would be equal to the price paid to recyclers plus the costs of collection. For recyclable items with a positive value, the price to consumers would be collection costs less revenues from recyclers.

[137]Costs of inconvenience may be absorbed by households, however.

such retail disposal charges merit consideration. First, where unit curbside collection charges are judged to be impractical (because of high transaction costs), for example, due to the prevalence of large, multi-unit residences, it is at least theoretically possible that retail disposal charges could serve as a second-best *substitute*. Second, for specific products which result in especially high disposal costs, in excess of costs associated with their volume, a retail disposal charge could represent a *supplement* to unit curbside fees. Such charges might be considered for a very limited set of household products which have serious environmental consequences when they find their way into landfills or incinerators.[138]

Like unit curbside charges, retail disposal charges should be tailored to the conditions of particular communities. Since disposal costs vary greatly by geographic area, any disposal charges applied to retail products should likewise vary. A potential advantage of this approach, compared with unit curbside charges, is that incentives for illegal dumping would not exist, since disposal costs would be incurred by individuals when products were purchased, not when they were thrown away.

There are several critical concerns associated with designing a useful retail disposal charge system. First, disposal costs depend upon the type of disposal and recovery technology used,[139] but it is impossible to know the social disposal cost at the time a product is purchased, since this cost depends upon how and where the consumer uses and disposes of the product. Second, such programs are likely to be complicated to implement, with consequently high administrative costs. Third, it is questionable whether charges would be set high enough to influence consumer behavior. For a community facing typical disposal costs on the order of $100/ton, for example, a metal can weighing 1/10th of a pound would incur a charge of one-half cent. It seems unlikely that such charges would have much impact on purchasing and disposal patterns and resulting solid waste problems.

Virgin Material Charges

A third, alternative approach of improving price signals for solid waste management would be to incorporate disposal costs at the point of production by levying charges on virgin materials to reflect their eventual disposal costs. Among both firms and consumers, such charges would encourage switching to materials and products with lower costs of disposal. Recycled materials would be favored, since the costs of virgin materials would rise relative to the costs of secondary ones.

The principal advantage of virgin material charges would be their relative ease of administration -- particularly in comparison with retail disposal charges. A clear disadvantage of such charges, however, would be their insensitivity to local conditions, since these charges would need to be computed on a standardized

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[138]While unit curbside charges generally will be superior to retail disposal charges, the latter are preferable to outright product bans on goods with high disposal costs. Such bans give consumers no option to buy a good that they may find indispensable and for which they would be willing to pay the full social costs of disposal.

[139]If the product is reused, then the social disposal cost is minimal. If a container is separated, then the social disposal cost is the net salvage value of the recycled container (i.e., the market price of recycled material less the costs of collection and recycling). If it goes to an incinerator, then the social disposal cost is the net value of the energy recovered (i.e., the market price of energy generated less the costs of collection and incineration, including the costs of hazardous air emissions and hazardous ash). If it goes to a landfill, then the social disposal cost is the cost of collection plus the value of the space occupied and the costs of operating the landfill, including the real cost of environmental impacts.

national basis. 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 could theoretically be effective in creating demand for recyclable materials, they would not be nearly as effective as unit curbside charges in encouraging the right mix for each community of recycling and disposal technologies.

USING THE MARKET TO FOSTER RECYCLING

Throughout this chapter, we emphasize the importance of providing better price signals at the local level (for consumers, producers, and decision-makers in municipal governments). Greater reliance on accurate unit pricing of curbside collection, while not a panacea, would be an important step in that direction. In this part of the chapter, we investigate a policy mechanism which could conceivably serve either as a partial *substitute* for such a pricing approach for municipal solid waste or as a *supplement* for circumstances in which specific products result in particularly high disposal costs in excess of costs associated with their volume. For situations in which increased recycling of specified products is correctly judged to be an appropriate means to achieving legitimate waste management goals, we now examine a mechanism which uses the forces of the market to encourage recycling. As such, this approach -- recycling credits -- holds promise of achieving given recycling targets at minimum aggregate cost to society.[140]

For a variety of reasons, policy makers increasingly view recycling as an important element of viable waste management strategies. By 1989, 26 states and the District of Columbia had some form of comprehensive recycling law, twelve of these being passed or revised in 1989 alone.[141] One year later, 38 states were found to have enacted various laws which promote recycling through bans, mandates, taxes, or tax incentives. For many policy-makers, recycling offers promise of reducing the amount of waste that ends up in landfills, but as more states and municipalities have adopted recycling programs, the increased supply of recovered materials has often outpaced demand in secondary markets. In some instances, this glut has even resulted in the subsequent landfilling of separated, recyclable materials.[142] In order to bolster demand for recycled materials, several states have enacted legislation requiring manufacturers in certain industries to increase the use of recycled (secondary) materials in their products.[143]

Such state actions have led to calls for a Federal role in setting *national* recycled content standards. Although national standards could provide consistent requirements for manufacturers and limit their need to

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[140]This part of the chapter draws, in part, upon a paper prepared for Project 88/Round II by Terry M. Dinan, "Increasing Recycling Through Marketable Permits: Implementation Issues."

[141]See: *Special Report: Recycling in the States. Update 1989*. Washington, D.C.: National Solid Waste Management Association, 1989.

[142]See, for example: Gold, Allan R. "As Trash is Recycled, Where Can It All Go?" *New York Times*, October 3, 1990, p. B4.

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

meet diverse state and local standards, consideration of such standards prompts reasonable concern regarding the costs they would impose upon both industry and consumers.

Overview of Recycling Targets and Tradeable Permits

Recycling content regulations in isolation could lead to significant economic inefficiencies because such uniform standards ignore the great degree to which the costs of compliance will vary among firms. Some manufacturers, for example, may not have the capacity to use secondary materials effectively with their existing production technologies, and for some of these, new capital investments would be prohibitive. Conversely, other firms with different technologies may be able to meet and even exceed minimum-content requirements at relatively low cost. Thus, recycled-content requirements could be made more cost effective through the use of permits which were tradeable among firms.

Under such a system, the Federal government could set an industry-wide recycling rate (or recycled content standard) which individual firms could meet in one of two ways: they could use the required percentage of secondary materials *or* they could use fewer secondary materials and buy permits (credits) from other firms which exceeded their recycling requirements. To ease potential disruptions, standards could start low and increase gradually over time. The result of a tradeable permit program would be that the same amount of total recycling would occur as under a uniform standard, but the total costs of compliance would be less, since those firms in the best position to recycle (or use recycled materials) would essentially be paid by other firms to undertake the bulk of the recycling burden.

Potential Applications of Recycling Credits

Recycling credit systems could conceivably be used for a variety of products. Of these, three have received substantial attention, and are briefly examined here -- newsprint, lubricating oil, and lead acid batteries.

(1) Newsprint

Although most of the country's major newspapers utilize newsprint with some recycled content,[144] overall demand has not kept pace with the growing supply. Nor has the increasing demand from other sectors that can utilize old newsprint absorbed the excess supply. As a result, the price paid for old newspapers has declined substantially. Some industry analysts have suggested that demand for old newsprint is likely to increase in the next few years as new mills and equipment come on line, but if this does not occur and demand does not increase, it is unlikely that newspaper recycling will increase substantially beyond its present rate of 32%.

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[144]The use of recycled newsprint varies among major newspapers. While the *Los Angeles Times* and the *Chicago Tribune* have recycling rates of 50% and 45% respectively, the rates at other newspapers have been much lower. For example, the newsprint recycling rate at the *Wall Street Journal* in 1989 was 2.5%, *USA Today* was 0.0%, the *New York Times* was 8.0%, and the *Washington Post* was 5.0%. See: *National Journal*, May 26, 1990, p. 1296.

A newsprint recycling credit program would first establish some minimum (aggregate) content standard for newsprint and possibly paper board produced for the U.S. market. But, rather than setting a uniform content requirement for all manufacturers, the program would use tradeable permits to achieve industry-wide aggregate standards while providing substantial flexibility to individual firms. Under such a program, newsprint and paper board producers and importers would be obligated either to: produce or import newsprint and paperboard having the required recycled content; or buy permits from other firms producing or importing newsprint or paperboard having a recycled content in excess of the standard. Thus, for example, if a newsprint standard was set at 40% recycled fibers, a newsprint manufacturer using a smaller fraction in its production (perhaps because it was located relatively far from sources of old newspapers) could purchase permits from a producer or importer using more than 40%. In this way, there would also be an economic incentive (potential revenue from recycled credit sales) for some producers to adopt improved technology which facilitates higher recycling levels.

(2) Lubricating Oil

Used motor-vehicle lubricating oil is another product which could be made subject to a recycling credit approach. Unlike the case of newsprint, the waste-management problem of concern is not one of space consumed in landfills, but rather human health and ecological impacts due to improper disposal. At present, about 30% of lubricating oil is recycled; more important, of the 14% of used oil generated by individuals ("do-it-yourselfers"), only 5% of that is typically recycled, and such consumers exhibit the highest incidence of illegal disposal.[145] Much of the unrecycled oil is placed in landfills, dumped into storm sewers, or burned illegally as heating fuel. This, in turn, can result in contamination of groundwater supplies (when placed in unsecured landfills), contamination of surface water supplies (from storm sewers), and air pollution (from illegal burning). Since such disposal costs are not reflected in the price of virgin oil, price signals for recycling used lubricating oil are distorted.[146]

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 recycling credit system could reduce the need for much of this by increasing market demand for reprocessed oil. By driving up the price offered for used oil, the system could encourage consumers to return oil to collectors, collectors to reprocessors, and reprocessors to new oil product manufacturers. On the other hand, if our major concern is with used oil being dumped by "do-it-yourselfers," the program might be less attractive than otherwise,[147] since the environmental gains which the program would bring would also be less.

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[145]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.

[146]Compounding these problems is pronounced reluctance by service stations and transporters to accept used oil because of fears of liability. Under the liability provisions of Superfund, any party involved in the generation, transportation, or disposal of a waste can be held fully liable for the full costs of the clean up. See: Schulze, Stewart. "Used Oil Hauler Loses Everything as EPA Tackles Waste Oil Sites." *Fuelline*, March 1988, pp. 4, 14, 15, 18; and Cook, Kevin. "Yerger vs. EPA: Innocent Mistake, Costly Consequences." *Fuelline*, September, 1986, pp. 4, 22, 23.

[147]Relative to a deposit-refund system, for example; see discussion later in the chapter.

Under a recycling credit system, an overall recycling target would be established for the U.S. motor oil industry, and oil reprocessors would generate credits by recycling used lubricating oil. Oil manufacturers and importers could meet targets by reprocessing lubricating oil themselves, by purchasing it from a reprocessor or by purchasing recycling credits (from oil reprocessors or other manufacturers who exceeded the standard).

(3) Lead Acid Batteries

A third product opportunity is lead acid motor-vehicle storage batteries. There continues to be great concern regarding the amount of lead which enters landfills and incinerators. Most of this lead is within storage batteries. A substantial amount of lead from motor-vehicle batteries is recycled each year, but the share of batteries recycled has been trending downwards for over 30 years.[148] At present, over 20 million unrecycled batteries enter the waste stream annually, and it is estimated that this may increase by more than 30% by the year 2000.[149]

If the price of virgin lead reflected its full social production and disposal costs, there would be higher recycling rates.[150] A virgin materials charge could be used to reflect the environmental risks associated with improper disposal. An alternative approach, aimed simply at increasing the recycling rate, would be a recycled content requirement linked with tradeable permits.[151] Like the other recycled content programs discussed above, an industry-wide recycled content standard would first need to be established. Individual firms could then meet their targets by purchasing recycled lead from secondary smelters or by buying credits from battery manufacturers who had exceeded their targets.[152]

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[148]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.

[149]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.

[150]See: Putnam, Hayes, and Bartlett, Inc. "The Impacts of Lead Industry Economics and Hazardous Waste Regulations on Lead-Acid Battery Recycling: Revision and Update." Report to the Office of Policy Analysis, U.S. Environmental Protection Agency. Cambridge, Massachusetts, September 1987.

[151]It is not necessarily the case, however, that increased recycling of batteries would result in positive net environmental consequences, since lead enters the environment not only from landfills, incinerators, and primary smelting operations, but also from secondary smelters and the recycling process.

[152]A potential problem is that as the demand for old batteries is increased and the price of secondary lead rises, incentives for the theft of batteries may likewise increase.

Conditions for a Successful Recycled Credit Market

The full measure of potential cost savings offered by tradeable permits can be realized only if efficient markets develop. Four conditions are necessary for this to occur: (1) firms must comply with the policy; (2) transaction costs must be sufficiently low so that they do not prevent efficient permit exchanges from taking place; (3) the market for permits must be competitive; and (4) there must be sufficient certainty regarding the permit policy for firms to be willing to trade permits. Using recycled newsprint credits as an example, each of the conditions are briefly considered below.

(1) Compliance by Firms

For a tradeable permit (or any other) policy to be truly effective and operate at least cost, firms must comply with the policy's requirements; that is, firms must accurately report their use of recycled materials and they must buy the appropriate number of permits if their use is less than the required level. Monitoring and enforcement costs for government will increase roughly in proportion to the number of firms involved in the program.

In the case of old newspapers, it is important to recognize that of domestically utilized recovered newspapers, roughly 40% are used in the production of newsprint, another 37% are used by paperboard manufacturers, and the remainder are used mainly for tissue, insulation, and construction paper. An ideal policy would provide equal incentives for all end uses, but a policy that allowed all firms that use recovered newspapers to generate permits would greatly limit the feasibility of enforcement. This suggests a narrower focus on newsprint and perhaps paper board, since these two industries include about 80% of the domestic market; such an approach would substantially reduce the number and diversity of firms to be monitored.[153]

(2) Transaction Costs

The potential cost savings associated with tradeable-permit systems can be realized in practice only if trading involves sufficiently low transaction costs, including the costs of finding prospective buyers and sellers, as well as the costs of obtaining any necessary regulatory approval for trades.[154] In the case of newsprint, the important role played by imports -- 55% of total U.S. consumption -- may lead to high transaction costs, because U.S. firms lack information on foreign firms, making identification costly.[155] For

[153]Imports would present considerable complications for enforcement. While the number of domestic producers of newsprint is relatively small (21), many more firms import into the United States (915 in 1988). The recycled content of imported newsprint cannot be estimated easily, although information currently collected by the U.S. Customs Office would be useful. Further complications of content standards are related to trade policy. Canada, the major exporter of newsprint to the U.S., might well view such a system as involving trade protectionism. Canadian mills tend to use more virgin material because they acquire timber at prices significantly below cost and because they are relatively remote from supplies of recovered newspapers.

[154]See: Stavins, Robert N. "Transaction Costs and the Performance of Markets for Pollution Control." Discussion Paper, John F. Kennedy School of Government, Harvard University, Cambridge, Massachusetts, October 1990.

[155]The lead trading program was the first environmental trading program in which importers were included in the reporting population, but the problems created by the import situation for lead trading were relatively insignificant, because the amount of

products with potentially high transaction costs, brokers are likely to emerge to facilitate trading, by linking potential buyers and sellers of permits.[156]

Regulatory constraints can lead to high transaction costs in tradeable permit markets if firms must obtain government approval for each and every transaction.[157] Such regulatory constraints are likely to be most significant where localized environmental impacts are important, in order to ensure that "hot spots" of emissions do not occur. Since the objectives of recycling credit policies are simply to strengthen the national market for secondary materials, these hot-spot effects are simply not an issue. Under a trading system for newsprint, firms should be free to trade permits without acquiring official approval.

(3) Competitive Market Conditions for Permit Exchanges

The degree of competition in the permit market will affect the extent to which potential cost savings are realized.[158] Under competitive conditions, each firm decides whether to enter the permit market depending upon the market price of permits versus its internal costs of increasing the use of secondary materials. A firm that buys or sells a significant fraction of total permits traded may be able to influence their price. If such a firm manipulated prices to its own advantage, recycling will not be achieved at minimum cost.

If a 20% recycled-content standard, for example, was applied to newsprint production (and paper board manufacturers were excluded from the program), significant concentration in the permit market would indeed be possible.[159] The largest seller of permits could control 25% of the permit market and the two largest sellers combined could control up to 42% of the market.[160] This problem could be lessened by including paper board and other manufacturers in the program, but even in the narrower program, the ability of other firms to enter the permit market by installing recycling capacity would constrain the ability of the dominant firms to control permit prices.

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leaded gasoline imported was small, accounting for less than 5% of total leaded gasoline use.

[156]Brokers have been successful in lowering transaction costs in other tradeable permit markets, such as for lead and criteria air pollutants. See: Dudek, Daniel J. and John Palmisano. "Emissions Trading: Why is this Thoroughbred Hobbled?" *Columbia Journal of Environmental Law* 13(1988):217-256.

[157]See: Hahn, Robert W. "Economic Prescriptions for Environmental Problems: How the Patient Followed the Doctor's Orders." *Journal of Economic Perspectives* 3(1989):95-114; and Moore, John, L., Larry Parker, John E. Blodgett, James E. McCarthy, and David E. Gushee. *Using Incentive for Environmental Protection: An Overview*. U.S. Congressional Research Service, Report to Congress, 89-360 ENR, 1989.

[158]See: Hahn, Robert W. "Market Power and Transferable Property Rights." *Quarterly Journal of Economics* 99(1984):753-765.

[159]See: Dinan, Terry M. "Increasing the Demand for Old Newspapers Through Marketable Permits: Will It Work?" Paper presented at the Association of Environmental and Resource Economists Workshop on Market Mechanisms and the Environment, Madison, Wisconsin, June 7-8, 1990.

[160]The ultimate question is whether other firms present credible threats of entry to the market, i.e., whether the market is "contestable." See: Baumol, William J., John Panzer, and Robert Willig. *Contestable Markets and the Theory of Industrial Structure*. New York: Harcourt Brace Jovanovich, 1982.

(4) Certainty in the Permit Market

Firms can be expected to trade permits only if the rights that these permits bestow are clearly defined and there is little or no question involving the legitimacy of transactions. A potential source of uncertainty for buyers of recycling permits is whether firms that sell permits are actually producing (or importing) products with recycled content in excess of the standard. A possible solution is to place accountability for permit legitimacy with sellers rather than buyers. Under such a system, permits could be registered with the government, which would have sole enforcement responsibility.

Uncertainty about the future market for permits may create reluctance on the part of firms to engage in trades and/or invest in the ability to use recycled materials. This is particularly important in newsprint, where the installation of de-inking equipment typically requires up to three years. This source of uncertainty could be resolved through the use of long-term permit contracts between firms. By entering into long-term agreements, firms considering investments in de-inking capacity could increase the certainty of their return from permit sales over their investment horizon.

USING MARKET MECHANISMS TO REDUCE LITTERING AND ILLEGAL DISPOSAL

Improved price signals and recycling credit programs can reduce the volume of waste reaching landfills and incinerators. Another pressing waste-management issue, however, is the improper disposal of wastes, including (nonhazardous) litter with its potential aesthetic consequences and toxic materials which may create human health risks and/or ecological damages. In this part of the chapter, we consider a market mechanism which is particularly promising for waste management problems associated with littering and other illegal disposal -- deposit-refund systems,[161] whereby consumers and/or producers pay a special charge when purchasing specific products, that charge being refundable when the product is returned for recycling or proper disposal.[162]

Overview of Deposit-Refund Systems

As the costs of legal disposal increase, incentives for improper (illegal) disposal also increase. Hence, waste-end fees designed to cover the costs of disposal, such as unit curbside charges, can in theory lead to increased incidence of illegal dumping. As was previously noted, this appears not to be a problem in Seattle and other cities which have moved toward unit pricing, and in any event this is unlikely to be a serious problem for wastes which do not pose significant health or ecological risks. In the case of general litter, it may well

[161] As we explain below, this policy mechanism could conceivably serve either as a partial *substitute* for pricing approaches for municipal solid waste or, more likely, as a *supplement* for circumstances in which specific products result in particularly high disposal costs in excess of costs associated with their volume.

[162] This part of the chapter draws, in part, upon a paper prepared for Project 88/Round II by Bradley W. Whitehead, "Deposit-Refund Systems for Waste Management." 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.

be that a combination of increased litter pick-up and stiff penalties for illegal disposal will be sufficient to mitigate the problem.

For some specific types of waste, however, which pose significant health or ecological impacts, *ex post* clean up is a much less attractive option. For these waste products, the prevention of improper disposal is particularly important. One alternative might seem to be a front-end tax on waste precursors, since such a tax would give manufacturers incentives to find safer substitutes and to recover and recycle taxed materials. But substitutes may not be available at reasonable costs, and once wastes are generated, incentives that affect choices of disposal methods would still be problematic.

This dilemma can be resolved with a special front-end charge (deposit) combined with a refund payable when quantities of the substance in question are turned in for recycling or disposal. This refund can provide an incentive to follow rules for proper disposal (and to prevent losses in the process in which the substance is used). The mechanics of the system would vary by product, but the general framework is that producers or initial users of regulated materials would pay a deposit when those materials entered the production process. In principle, the size of the deposit would be based upon the social cost of the product being disposed of illegally. As the product changes hands in the production and consumption process (through wholesalers and distributors to consumers), the purchaser of the product would pay a deposit to the seller. Thus, once the producer sells the product, responsibility for proper disposal would be passed to the next party, this process continuing until the ultimate consumer of the good had turned the product in to a certified collection center responsible for recycling or proper disposal.

Deposit-refund systems are most likely to be appropriate when the incidence and the consequences of improper disposal are great (although these systems have frequently been portrayed -- incorrectly -- as mechanisms to foster greater levels of recycling). In general, properly scaled deposit-refund systems can be attractive for three reasons. First, government's monitoring problem is converted from the nearly impossible one of preventing illegal dumping of small quantities of waste at diverse sites in the environment to what may be the more manageable problem of assuring that products being returned for refund are what they are purported to be. Second, there will also exist an incentive to prevent losses of the material in the industrial process in which it is used. Third, because of inevitable net losses in the production and consumption processes, incentives will exist for firms to look for less environmentally damaging substances -- that is, substances to which the deposit-refund system does not apply.[163] For some products, a nationwide approach may be appropriate if: firms face national markets and products are easily transportable; toxicity problems associated with improper disposal do not vary greatly by geographic area; and the national approach is likely to be less costly for manufacturers and recyclers than a diversity of state or local programs.

Before examining some specific potential applications of deposit-refund systems, it is useful to review the major current application of this approach -- state-level "bottle bills" for beverage containers. An examination of these systems provides some insights into the potential merits *and* the likely limitations of the approach. Deposit-refund systems have been implemented in nine states in the U.S. and several provinces in Canada to reduce littering and reduce the flow of solid waste to landfills. In most programs, consumers pay a deposit at the time of purchase which can be recovered by returning the empty container to a redemption center. Typically, the deposit is the same regardless of the type of the container. In some

[163]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.

respects, these bills seem to have accomplished their objectives; in Michigan, for example, the return rate of containers one year after a program was implemented was 95%;[164] and in Oregon, littering was reduced and long-run savings in waste management costs were achieved.[165]

By charging the same amount for each type of container material, however, these programs do not encourage consumers to choose containers with the lowest product life-cycle costs (including those of disposal). In particular, bottle bills may encourage a shift of consumer purchases from metals to plastics, which are less recyclable with current technology. Furthermore, by requiring consumers to separate containers and deliver them to redemption centers, deposit-refund systems can foster net welfare losses, rather than gains.[166] Additionally, by removing some of the most profitable elements from the waste stream, bottle bills may undermine the viability of more comprehensive recycling alternatives, such as curbside recycling programs. In general, bottle bills may be more effective at reducing littering than at encouraging recycling, since there is no guarantee that collected containers will not wind up in landfills (due to market conditions). This last point is simply a reminder that deposit-refund systems are most likely to be appropriate when the objective is one of reducing littering and illegal disposal (as opposed to such objectives as general reductions in the solid waste stream or increased recycling).

Potential Applications

Deposit-refund programs have been proposed for a variety of products, including vehicle tires and car bodies. The strongest case can be made for deposit-refund systems, however, for products with very high costs of improper disposal, since the costs of separation and redemption are more likely to be small relative to the benefits of proper disposal. Examples of products that may be conducive to regulation through deposit-refund systems include lead acid batteries, used lubricating oil, and certain industrial chemicals, such as chlorinated solvents.

(1) Lead Acid Batteries

An alternative to the recycling-credit program described above as a means to reducing the quantity of lead entering unsecured landfills and other potentially sensitive sites would be a deposit-refund program for lead acid motor vehicle batteries. Under such a system, a deposit would be collected when manufacturers sold batteries to distributors, retailers, or original equipment manufacturers; likewise, retailers would collect deposits from consumers at the time of battery purchase. Consumers could collect their deposits by returning their used batteries to redemption centers; these redemption centers, in turn, would redeem their deposits from

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[164]See: Porter, Richard. "Michigan's Experience with Mandatory Deposits on Beverage Containers." *Land Economics* 59(1983):177-194.

[165]U.S. General Accounting Office. *Solid Waste: Trade-offs Involved in Beverage Container Deposit Legislation*. Report #GAO/RCED-91-25. Washington, D.C., 1990.

[166]The social desirability of mandatory deposit laws depends critically on the value of the time it takes consumers to return empty containers. See: Porter, Richard. "A Social Benefit-Cost Analysis of Mandatory Deposits on Beverage Containers." *Journal of Environmental Economics and Management* 5(1978):351-375.

battery manufacturers, etc. The program would be largely self-enforcing, since participants would have incentives to collect deposits on new batteries and obtain refunds on used ones.

An advantage of a deposit-refund approach, compared with a recycling credit system, is that the former focuses explicitly on reducing improper disposal as the policy goal.[167] A national program could be designed to accommodate existing deposit systems for batteries, such as those found in Maine and Rhode Island. A problem inherent in either approach, however, is the increase in incentives for battery theft. The higher the deposit, the greater the incentive for theft, particularly if one only needs to show up at a redemption center with a battery to claim a refund. An alternative would be to require a sales receipt upon redemption or to permit refunds only for those exchanging an old battery for a new one. Either of these alternatives, however, will reduce the comprehensiveness of the program.[168] In any event, a deposit of $2 per battery, for example, would be greater than the typical market value of used batteries. Such a deposit should be small enough to avoid much of the theft problem but large enough to encourage a substantial level of return.

(2) Lubricating Oil

A deposit-refund system could also provide an alternative to recycled content standards for used lubricating oil.[169] The simplest version of such a program would require consumers to pay a deposit to retailers for each quart of oil purchased, and they could receive a refund by returning the used oil.[170] Redemption centers would sell used oil to recyclers or would have to 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 (as with batteries). An advantage of a deposit-refund system for used lubricating oil, relative to the recycled content policy outlined above, is that it can be targeted at "do-it-yourselfers," whose recycling rate is only 5% and who are collectively responsible for nearly 50% of illegal dumping. A problem with the deposit-refund approach for lubricating oil, however, would be difficulties (costs) associated with detecting counterfeit product.

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[167]Furthermore, the transaction costs of a deposit-refund system for lead-acid motor vehicle batteries should be much smaller than the transaction costs for a comparable recycling credit system, since the former is based upon an infrastructure which already exists.

[168]Requiring a sales receipt for a refund 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.

[169]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.

[170]A potential problem is that a smaller amount of used oil is typically drained than is originally purchased, since some part may leak from the engine or essentially be emitted as part of tailpipe exhaust.

(3) Industrial Solvents

Deposit-refund systems may be a cost-effective instrument for ensuring safe management and disposal of certain containerizable hazardous chemicals. About 30% of industrial hazardous wastes are types which may be generated in small enough quantities per unit to be containerized. Of those, almost half are in 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 for emissions to the environment of the 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 such category of chemicals are chlorinated solvents. While most chlorinated solvents are recycled to some degree by the thousands of firms using them, two problems need to be addressed. First, some of the solvent escapes in the production process and is released into the atmosphere. Second, 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 would presumably pay the deposit plus the amount normally offered for spent solvent). Under this system, improper disposal would be discouraged since firms would have incentives to recoup their deposits, and incentives would exist to minimize on-site losses by installing equipment to control vapor losses or by 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 its use and thus encourage firms to seek out alternatives.

The administrative complications associated with such a program should not be under-estimated. As with used lubricating oil, verification would likely 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 the consistency of water. Testing of solvent shipments would be needed to determine the appropriate refund.[171]

ADDRESSING NIMBY: THE SITING OF NEW WASTE MANAGEMENT FACILITIES

Having examined a series of incentive-based measures which -- to different degrees would encourage source reduction of waste streams of various kinds, it must be recognized that a major component of both hazardous and conventional waste-management problems is the dwindling number of sites available for ultimate disposal (and recycling). Even with the most ambitious of source-reduction programs, new facilities for proper disposal of waste will be required, but the infamous NIMBY -- "Not-In-My-Backyard" --

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

problem plagues virtually every public or private effort to establish a new disposal site.[172] In this part of the chapter, we examine a potential new approach to the NIMBY problem, not as a panacea, but as one possible supplement to the range of policies currently being considered.

The difficulty of siting new municipal and hazardous waste facilities has largely been a consequence of increased distrust of government and growing environmental awareness.[173] Local protests have been effective in delaying or causing the cancellation of many projects, especially in the case of landfills and incinerators. Citizens mobilize against such facilities because of concerns regarding contamination of drinking water and pollution of air, and because of concerns that the stigma associated with such facilities will lower property values or affect quality of life in less tangible ways.

A Potential Approach for Siting New Facilities

A frequent prescription for breaking the current logjam is greater public participation in the site planning process, but it is unlikely that even the most extensive and intensive planning process could fully overcome local NIMBY opposition to new waste-management facilities. Likewise, negotiations between communities and waste-facility developers have not overcome NIMBY opposition, and simple state or Federal preemption of local authority is not a satisfactory alternative.

One promising approach might be for states to grant local communities the power to decide whether to accept the siting of facilities within their boundaries *provided* the communities hold binding referenda on all bona fide proposals.[174] The property rights to impose any risks need to be clarified as a condition for negotiations between developers and potential host communities. If a developer has purchased land for a waste facility and acquired necessary state and local permits, either the developer or the community controls the right to proceed with the facility. If the developer holds the right, the community can in principle buy him or her out; if the community holds the right, the developer would need to compensate the community in some way. A mutually acceptable compensation package might include some combination of the following: (1) guarantees against property-value decreases; (2) incentive payments to communities (which could be

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[172]The NIMBY problem affects not only the siting of waste disposal facilities, but all kinds of infrastructure development projects. On this, see: "Overcoming NIMBY: New Approaches to Resolving Siting Disputes." *The Public's Capital*, volume 2, number 3, Winter 1991.

[173]In other cases, environmental or economic regulation has prevented the opening of new waste management facilities. For a discussion of how conventional regulation of waste hauling and disposal in New Jersey effectively ended investment in new landfills, see: Kleindorfer, Paul R. "Economic Regulation of Solid Waste Collection and Disposal: Comparative Institutional Assessment." Working Paper 88-05-01, Wharton School Risk And Decision Process Center, University of Pennsylvania, Philadelphia, July 1988; and Passell, Peter. "The Garbage Problem: It May Be Politics, Not Nature." *New York Times*, February 26, 1991, pp. C1, C6.

[174]This part of the chapter draws, in part, upon a paper prepared for Project 88/Round I by Robert Cameron Mitchell, "Hazardous Waste Facility Siting." For further discussion of this idea, see: Mitchell, Robert Cameron and Richard T. Carson. "Property Rights, Protest, and the Siting of Hazardous Waste Facilities," *American Economic Review Papers and Proceedings* 76(1986):285-290.

earmarked to reduce property taxes or for other purposes); (3) outside monitoring of facilities to ensure safety; (4) accident insurance; and (5) credible guarantees of non-abandonment.[175]

Affected communities may have little incentive to negotiate if they believe that they can stop projects entirely. As a result, a number of states have experimented with different approaches to the siting stalemate, none of which have successfully resolved the property rights issue. The establishment of state siting boards with power to preempt local governments represents an attempt to reassert the former property right regime with little success; and the concurrent establishment of schemes for compensating communities for the presence of waste facilities represents a movement toward giving the property right to the community. A Massachusetts siting law has both features with a strong emphasis on the latter, but no facilities have been sited under this law, suggesting that compensation without ultimate local authority for decisions may not be a successful strategy.

One possible remedy is for states to require the use of referenda to determine local approval or rejection of proposed waste facilities. Thus, the relevant local political authorities would be required to hold a referendum when requested by a qualified developer meeting state requirements. The terms of any compensation/mitigation package, proposed by the developer, would be incorporated into the ballot proposal. Developers would have strong incentives to develop winning proposals; they would aim at selecting potential sites where voters would be more likely to agree to the least expensive package of measures designed to compensate a community for accepting a facility. The costs of a package would be passed on to enterprises which wished to use the facility. This method of paying for the compensation package transforms the concentrated costs (to the local community) into more equitably shared burdens borne by the facility's ultimate beneficiaries.

For many years, local areas, such as poor rural communities, have accepted undesirable land uses essentially in exchange for economic development (without explicit compensation packages). Increased use of compensation mechanisms -- as in the binding local referendum proposal considered here -- could tend to reinforce this tendency to site waste facilities in poorer communities or regions. Therefore, this and similar approaches are subject to criticism on grounds of equity. Since many people view direct financial compensation as no more than legal bribery, there is reason to consider instead the use of compensation packages which match not only the magnitude but also the form of any local concerns. Thus, specific safety precautions could be employed to address safety concerns, and mitigation measures could be undertaken to address environmental concerns. Furthermore, recall that the binding-referendum-compensation-mitigation mechanism would have the effect of transforming locally concentrated costs into more equitably shared burdens borne by a waste facility's ultimate population of beneficiaries.

Granting power to communities reduces incentives to be intransigent in dealing with developers; and binding referenda would mean that local officials and community leaders could participate in negotiations without being accused of selling out their community, since the community as a whole would have the final say. With increasing experience, this approach may have the potential to help states and municipalities locate sites for waste facilities in a manner which is both efficient and equitable.

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[175]In Wisconsin, negotiated compensation packages have included guarantees on land values near landfill sites, free disposal for local communities, and oversight of facility operations. Local compensation is also provided for under state programs in Maine, Massachusetts, Minnesota, New Jersey, and Tennessee. See: American Planning Association. *Solid Waste Management: Planning Issues and Opportunities*. Planning Advisory Service, Report Numbers 424 and 425. Chicago, Illinois, 1990.

A PORTFOLIO OF WASTE MANAGEMENT POLICIES

In order to assemble a portfolio of waste management policies, it is first necessary to identify each problem to be addressed. Is the problem insufficient capacity of landfills, or is it littering or other forms of illegal disposal? In seeking to answer such questions, it becomes clear that there is a significant difference between means and ends, between policy mechanisms and goals or objectives. Increased recycling, for example, may be a valid means to achieving some legitimate waste management goals, but recycling *per se* should not -- any more than landfilling *per se* -- be seen as a general objective of waste management policy.

The objectives of waste management policy presumably include protecting human health and ecological values, while providing sufficient waste management services at minimal cost. In many cases, perhaps in all cases, recycling will be part of the optimal mix of technologies -- along with landfilling and incineration -- which will enable us to reach legitimate waste management goals. The question becomes what policies, what specific policy mechanisms belong within our overall portfolio of solid and hazardous waste management strategies?

For problems which are associated with the imbalance between the supply and demand of solid waste management services, incentive-based policies which focus on providing better price signals will be key. In most circumstances, the first reform which ought to be considered is accurate unit pricing of curbside collection and disposal. This local initiative can go a long way toward fostering the cost-effective mix of landfilling, incineration, and recycling, while reducing the magnitude of the overall solid waste stream.

In special circumstances, there may be a role for retail disposal fees or virgin material charges. The former merit consideration as a supplement to unit curbside collection charges for specific products which result in especially high disposal costs, including those household products which have serious environmental consequences when they find their way into landfills or incinerators. Likewise, virgin material charges might be considered for those substances which will not be adequately addressed by unit curbside charges. A possible example is primary lead production.

Improved price signals will not be a panacea for all of our waste management problems. Either as a partial substitute for the pricing approach or as a supplement for products with particularly high disposal costs, recycling may be found to be an appropriate means of achieving legitimate waste management goals. In such cases, recycling credits -- where tradeable permits are combined with recycled content standards -- hold promise of achieving given recycling levels at minimum aggregate cost to society. Potential applications include newsprint, motor-vehicle lubricating oil, and lead acid batteries.

Although recycling credit programs and improved price signals can reduce the volume of waste reaching landfills and incinerators, in some cases our concern is with the improper disposal of wastes, and the aesthetic, health, and ecological consequences which can follow. In such cases, an ideal incentive-based approach can be that provided by deposit-refund systems. Long applied to bottles and cans, these systems may be more appropriate for certain kinds of containerizable waste, including lead acid batteries, lubricating oil, and industrial solvents.

Encouraging greater levels of source-reduction is not enough; new facilities for proper disposal of municipal solid waste and hazardous waste will be required. The NIMBY problem stands in the way, but it

can be addressed by innovative approaches, such as a package which combines local siting authority, binding referenda, and appropriate compensation and mitigation measures.

Where does this leave us? The answer is that we conclude the chapter where we began, recognizing that since waste management is not a single policy issue, but a label for a broad range of diverse environmental problems, it should not be surprising that an equally diverse set of policy mechanisms may be required to address this set of challenges.

CHAPTER 4
NATURAL RESOURCE MANAGEMENT

Of the many environmental problems facing the nation, the management of the public domain of natural resources remains one of the most contentious areas of concern. Our use of water supplies is an ongoing sphere of controversy, particularly in the arid western part of the country, where supplies are especially scarce and where episodes of drought will periodically test the capacity of existing facilities and institutions. Another area of great concern focuses on the management of the nation's public lands, including our national forests. Inefficient management of this valuable resource has resulted in a diverse set of environmental problems.

The western U.S. is plagued by inefficient use and allocation of its scarce water supplies, partly because existing subsidies and other public policies mean that users do not have appropriate incentives to take actions consistent with economic and environmental values. This results sometimes in grossly inefficient use of existing supplies. To address this problem, we investigate in the first part of the chapter a promising policy mechanism -- voluntary market-oriented transfers of water rights to foster rational conservation measures, better allocate supplies among competing uses, and improve water quality.

Sound management of the public lands of the U.S. is also impeded by costly subsidies that exist for a few extractive industries, at the expense of environmental values. Below-cost timber sales -- where the U.S. Forest Service does not recover the full cost of making timber available -- provide a major example. Excessive timber cutting, substantial loss of habitat, and damage to watersheds are among the environmental harms which result. Gradual removal of these subsidies would foster environmental protection and increase net Federal revenues. In the second part of the chapter, we investigate policies to implement this important reform.

IMPLEMENTING WATER MARKETS

Federal water policy originated to further westward expansion and frontier development. More recently, water pollution control laws have been enacted in response to degradation of water resources. But a variety of water allocation and water quality problems remain. One promising approach is to remove

barriers to water marketing which interfere with economically sensible conservation and environmental protection.[176]

The Problem: Water Scarcity and Its Environmental Consequences

The severe droughts experienced this year in California and two years ago in other parts of the West have dramatized the reality that water is not an unlimited resource. Surface reservoirs have been drawn down to record low levels, and overdrafts of underground aquifers have accelerated. These droughts are not isolated or anomalous events, and it is becoming increasingly clear that Federal and state water policies have aggravated, not abated, these problems.[177]

Table 4-1: Estimated Consumptive Freshwater Use by State, 1985

	Shares of Total Use by Sector			Total Use (millions of gallons per day)
	Irrigation	Domestic	Other	
Arizona	85.4%	7.4%	7.2%	3,712
California	91.2%	4.2%	4.7%	21,172
Colorado	94.2%	3.0%	2.8%	4,853
New Mexico	83.0%	6.9%	10.1%	1,530
Utah	86.1%	5.3%	8.6%	2,253
Wyoming	95.8%	1.1%	3.1%	2,673
All Six States	90.7%	4.3%	5.1%	36,193

Source: MacDonnell, Lawrence J. *The Water Transfer Process As a Management Option For Meeting Changing Water Demands, Volume I*. Submitted to the U.S. Geological Survey, Washington, D.C., April, 1990.

Due to the natural scarcity of water in the western U.S., that part of the country is particularly sensitive to problems associated with dwindling supplies. The water resources in many areas of the West

[176]This part of the chapter draws, in part, upon a paper prepared for Project 88/Round II by Lawrence J. MacDonnell, "Water and the Environment: Using Markets for Environmental Benefits."

[177]See: Anderson, Terry L. *Water Crisis: Ending the Policy Drought*. Washington, D.C.: Cato Institute, 1983; Frederick, Kenneth D., ed. *Scarce Water and Institutional Change*. Washington, D.C.: Resources for the Future, 1986; El-Ashry, Mohamed T. and Diana C. Gibbons. *Troubled Waters: New Policies for Managing Water in the American West*. Washington, D.C.: World Resources Institute, 1986; and Wahl, Richard W. *Markets for Federal Water: Subsidies, Property Rights, and the Bureau of Reclamation*. Washington, D.C.: Resources for the Future, 1989.

are essentially fully utilized, a consequence of generally limited water supplies and extensive development over the past 140 years. Most withdrawals of water from surface and groundwater sources in the West are for use in irrigated agriculture. In 1985, irrigation accounted for over 90% of consumptive freshwater use in six western states -- Arizona, California, Colorado, New Mexico, Utah, and Wyoming. Domestic consumptive uses represented about 4% of the total, and other uses -- including industrial, commercial, and public-land uses -- accounted for slightly more than 5% (Table 4-1).

Rights to use water in the West are based on the prior appropriation doctrine and established primarily by state law.[178] Originally, water had to be physically appropriated and applied to a "beneficial use." If such a use is abandoned, the water right is lost. In time of shortage, senior users are satisfied first. This structure of rights was intended to encourage extensive, primarily out-of-stream uses, and until recently, the environmental consequences of this system were largely ignored. Among the increasingly competitive demands for limited western water resources, uses aimed at preserving ecosystems, maintaining wetlands, supporting fisheries, or providing for recreation are relative newcomers. Voluntary reallocation of water to some of these uses can occur through market-oriented water transfers, and can supplement state and Federal programs to protect instream uses.[179]

Overview of Water Marketing

Current laws and policies do not induce many of America's water users to take actions consistent with economic, environmental, and other social values associated with water resources. Inappropriate incentives promote inefficient use of existing supplies. Individual decision-makers simply do not bear the full social costs of their daily water-use decisions.

In the Central Valley of California, some farmers are paying as little as $10 for water to irrigate an acre of cotton, while just a few hundred miles away in Los Angeles, local authorities are paying up to $600 for the same quantity of water. This dramatic disparity is a reminder that increasing urban demands for water can be met at relatively low cost to agriculture or the environment.[180] By allowing markets in water, voluntary exchanges can take place which make both parties better off. When farmers have a financial stake in

[178]Federal law overlays and restricts some state-established uses. Federal reserved water rights for public lands and Indian reservations can be very important at the margin, where streams are fully appropriated under state law.

[179]Our focus on water-marketing issues does not suggest that this is the only viable approach to reforming and improving water allocation. Other areas that merit investigation include marginal-cost pricing (and metering) of urban water supplies, and reducing Federal subsidies (interest-free repayments) for irrigation water.

[180]This disparity between agricultural and municipal water pricing is perceived as a threat to agricultural water users, since they perceive cities as "water magnets." The exploitation of the Owens Valley's water rights by Los Angeles real estate interests in the early part of this century is a reminder of the ongoing friction and concern. On the other hand, it is important to note that even a doubling of urban supplies would imply only a modest reduction in agricultural uses (Table 4-1). Furthermore, this reduction might occur through water conservation, as in the case of the Imperial Irrigation District transfer described later in the text.

conserving water, when urban needs are met without shrinking agriculture and without building new dams and reservoirs, environmental protection gains.[181]

Measures which facilitate voluntary water transfers thus promote more efficient allocation of scarce water resources and curb the perceived need for additional, expensive, and environmentally disruptive water supply projects. A recent agreement for transferring 100,000 acre-feet of water between the farmers of the Imperial Irrigation District in southern California and the Metropolitan Water District in the Los Angeles area demonstrates this potential.[182] Further evidence of water marketing's efficacy comes from greatly increased interest in such transactions elsewhere in California, and in Colorado, New Mexico, Arizona, Nevada, and Utah.[183]

Existing State and Federal Water Transfer Policies

Rights to use water in the West are established at the state level under various types of legal entitlements. These rights are to the use of water, not to the water itself. The property interest is the right to use a set amount of water with a certain priority, and the ownership of a water right may typically be transferred so long as there is no change in the right's use and no adverse effects on other water rights holders. Water uses in the West are highly interdependent; diversions of water reduce the quantity of water available in the stream for downstream uses. At the same time, return flows from existing uses may provide the source of water for other uses. Groundwater uses may be supported by recharge of an aquifer from uses of water on land. Because of this interdependence, state review of water transfers has been primarily concerned with assuring that changes in the place and/or purpose of use under a water right do not impair uses of other water rights. In the early 1900's, as the dominant use of water shifted from mining to agriculture, several states established restrictions on transfers. In recent years, water transfers have gradually come to be viewed more favorably in the West and state water laws have been modified to facilitate them. Numerous restrictions, however, remain.[184]

Federal policy is also significant, since the U.S. Bureau of Reclamation has constructed over 200 projects in the 17 western states over a period of 90 years.[185] Originally Congress intended that the cost of

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[181]See: Passell, Peter. "Economic Scene: Greening California." *New York Times*, February 27, 1991.

[182]See: Stavins, Robert N. and Zach Willey. "Trading Conservation Investments for Water." *Regional and State Water Resources Planning and Management*, ed. R. J. Charbeneau, pp. 223-230. Bethesda, Maryland: American Water Resources Association, 1983.

[183]See: MacDonnell, Lawrence J. *The Water Transfer Process As a Management Option For Meeting Changing Water Demands, Volume I*. Submitted to the U.S. Geological Survey, Washington, D.C., April, 1990.

[184]Arizona requires approval of an irrigation district, agricultural improvement district or water users association whose water supply could be affected by the transfer. Idaho also requires the approval of the irrigation corporation or district if water rights are related to their supply systems. The Utah constitution prohibits municipalities from selling their water rights.

[185]These projects involve approximately 350 storage reservoirs, with an aggregate capacity of over 100 million acre-feet; about 30 million acre-feet of water annually are provided from those reservoirs. Of this, about 27 million acre-feet (90%) go to irrigation uses, while 3 million acre-feet meet municipal and industrial demands. See: U.S. Bureau of Reclamation. *1986 Summary*

irrigation projects would be repaid, interest-free, to the Federal government over 10 years, but this subsidy has been substantially increased since that time by extending the repayment period and by other measures. Transfers involving changes of use of Bureau-supplied water have not been common, but they have occurred, despite the fact that Federal reclamation law was not written at a time when transfers -- as we think of them today -- were common. Indeed, the original law provided that the right to water supplied by the Bureau is tied to the land irrigated.

Federal water transfers bring up a number of issues. Can water be transferred to a use not originally intended? Can water be transferred for use outside the original project area? Who can decide to make a transfer? Who must approve a transfer? What are the conditions for approval? For the most part, these questions still must be addressed on a project-by-project, transaction-by-transaction basis, although in December of 1988, the U.S. Department of the Interior issued a water-marketing policy statement representing an initial effort to establish general principles to apply to proposed water transfers. In short, it stated that the Bureau of Reclamation would facilitate voluntary transfers so long as agreement of all affected parties could be reached. This policy and subsequent regulations have provided clarification of a number of issues, but others have been left unanswered.

For many years, economists and others have pointed to the notable disparity between the value of water in many existing uses and its value in new uses as evidence of inefficient water allocation in the West. For example, it has been estimated that the value of most water uses in irrigation (and irrigation accounts for nearly 80% of all water use in the West) is less than $40 per acre-foot.[186] At the same time, studies have shown the value of water in new municipal, industrial, and recreational uses to be several times that amount. The conclusion reached by most who have studied this situation is that the lack of transfers is due to impediments that have prevented a functioning market in water transfers.

Designing Improved Water-Market Policies

Opening up water markets can bring environmental benefits in two ways: first, by facilitating reallocation of a portion of existing water supplies to new demands, water markets can reduce the need for additional water-storage facilities. Second, water transfers can provide a means of directly reallocating a share of existing consumptive uses to improving streamflows in some areas and assuring maintenance of wetlands in other areas.

A number of issues must be addressed, however, if transfers are to play a more significant role in meeting the changing water needs of the American West. First, there are many different forms of water entitlements in the West. In many cases, these entitlements lack the clarity necessary to allow transfers. A second issue concerns the quantity of water that is legally transferable. Because even junior appropriators are protected from loss of stream conditions upon which their appropriations are based, transfers are prohibited from causing adverse changes in the quantity and timing of downstream flows. In many situations this limits transfers to the quantity of water historically consumed, not just diverted, under the water right.

Statistics, Vol. 1. Washington, D.C., 1987.

[186]Young, Robert A. "Local and Regional Economic Impacts," *Water Scarcity: Impacts on Western Agriculture*, eds. Ernest A. Engelbert and Ann Foley Schearing, pp. 244-269. Berkeley: University of California Press, 1984.

A third issue concerns the standard of protection to be afforded other appropriators. Important flexibility can be added to the system if terms and conditions can be imposed on the transfer to offset possible injury.

Beyond issues related to the transfer process itself, there is the question of who will use transfers to make affirmative improvements in instream flows, wetlands, and other environmental benefits. Several states allow for existing consumptive water rights to be transferred to instream purposes, but do not provide funds for this purpose, relying instead on donations or other sources.[187] The Nature Conservancy has begun an active program of acquiring water rights for streamflow protection and improvement -- primarily associated with preserves that it owns and manages.[188]

(1) Improving State Water Transfer Law and Transfer Processes

Improvements can be made in the definition and certainty of existing water rights. Stream adjudications are underway in several states to clarify priorities and diversion rights of users on these streams. States should consider if adjudications on other streams are needed and if other steps are necessary to clarify existing water rights. There are still some explicit restrictions on transferability that the states should reconsider. Prohibitions on transfers of water outside the boundaries of a water district (or other defined geographical areas) should be removed, so that the possibility of such transfers can at least be considered. Any remaining restrictions on transfers involving a change in the place of use or a change from one type of use to another should also be removed.

It is also important to establish rules and requirements that can guide water transfers. States can begin, as California has done, by declaring a policy supporting water transfers and indicating that transferring water does not constitute evidence of lack of beneficial use (and consequent loss of water right). More importantly, states need to clarify the requirements that will apply. States should evaluate environmental effects of water transfers, but possible social and economic impacts of transfers are more difficult to evaluate. Transferrors could be encouraged to look for opportunities where net effects of transfers can be to strengthen the agricultural economy, rather than hurting it.

The Intermountain Power Project, for example, worked out an arrangement with local irrigation companies near Delta, Utah, to find sources of transferable water that would not impair the local economy. Similarly, an arrangement between the city of Casper and the Casper-Alcova Irrigation District in Wyoming involved salvage of water through improvements in the irrigation district's water delivery system. Water conserved is then available for use by the city. And the recent agreement between the Metropolitan Water District of Southern California (MWD) and the Imperial Irrigation District (IID) will allow MWD to use water

[187]See: MacDonnell, Lawrence J., Teresa A. Rice, and Steven J. Shupe, eds. *Instream Flow Protection in the West*. Boulder: University of Colorado School of Law, Natural Resources Law Center, 1989; and Wahl, Richard. "Acquisition of Water to Maintain Instream Flows." *Rivers* 1(1990):195-206.

[188]See: Wigington, Robert. *Update on Market Strategies for the Protection of Western Instream Flows and Wetlands.* Boulder, Colorado: Natural Resources Law Center, June, 1990.

conserved in the Imperial Valley.[189] Again, the net effect of the transfer will be to improve the irrigation economy in the Imperial Valley.

(2) Improving Transfers of Bureau-Supplied Water

Water stored in Federally constructed and operated facilities offers important opportunities for meeting water needs in many areas of the West. Reclamation law itself does not prevent transfers, but the absence of Congressional direction in this area almost certainly has inhibited transfer activity. By affirmatively setting forth a transfer policy, Congress could provide the framework necessary for the Bureau of Reclamation to establish a transfer process by making it clear that the purposes of Bureau projects are to facilitate the best uses of water resources.

The Department of the Interior could be directed to undertake a comprehensive review of existing contracts, policies, and operating procedures, with regard to effects on transfers, and to develop clear and consistent policies and procedures for transfers. Among the matters worth considering are: (1) whether transfers can be for a new use that was not the one originally authorized; (2) whether a proposed new use can occur outside a project service area's boundaries; (3) whether a change in purpose of use requires a change in repayment obligation; and (4) whether profits can be made in the transfer of Bureau-supplied water. This last issue is particularly contentious, because the water supplied to existing users, especially for irrigation purposes, is made available at a highly subsidized cost. Yet the value of this water to other users can be considerable, and preventing profits means preventing mutually-beneficial trades.

Assessing Water-Market Strategies

In spite of potential problems and deficiencies in existing laws and policies, some water transfers *are* occurring. Opportunities for mutual benefits are being found, deals are being made, and review requirements are being satisfied. If fewer water transfers are occurring than we believe would be in society's best interest, it is partly because of the kinds of market barriers identified here.

In an earlier era when developable water resources still existed and state review processes overseeing water rights were not well established, restrictions on water transfers may have been justified. But as we approach the acceptable limits of water development, our options must be reconsidered. Market-based water transfers can work well in many situations. They are voluntary arrangements that reflect the judgment of the parties involved that mutual benefits will be realized; many of the informational costs necessary to find arrangements that produce these benefits are borne by the parties themselves; and these transfers tend to move us in the direction of more efficient use of scarce resources. As states and the

[189]In March of 1983, the Environmental Defense Fund (EDF) published a proposal calling for MWD to finance the modernization of IID's water system in exchange for use of conserved water. See: Stavins, Robert N. *Trading Conservation Investments for Water*. Berkeley, California: Environmental Defense Fund, March, 1983. In November, 1988, after five years of negotiation, the two water giants agreed on a $230 million water conservation and transfer arrangement, much like EDF's original proposal to trade conservation investments for water. See: Morris, Willy. "IID Approves State's First Water Swap with MWD." *Imperial Valley Press*, November 9, 1988.

Federal government re-examine their current water-allocation policies in light of the increasing importance of some uses, market-based water transfers represent one avenue for this reallocation to occur.

A legitimate concern with increased reliance on water marketing is that the economic values associated with water resources are well-defined for some uses but not for others, particularly those associated with environmental amenities.[190] Water transfers *can* be used, however, for direct environmental benefits, as is demonstrated by the work of the Nature Conservancy.[191] Likewise, an important component of the proposed recovery program for endangered fishes in the upper Colorado River is the purchase and transfer of existing water rights to instream flow purposes. The U.S. Fish and Wildlife Service is working cooperatively with state agencies and others to acquire those rights and transfer their use to stream areas that are critical habitat.[192]

Cities located along streams have discovered the value of protecting flows because of associated recreational and aesthetic benefits, and groups like Trout Unlimited and Ducks Unlimited have become very active in finding ways to assure the availability of water for fish and wildlife. In some cases, they have been able to provide the funds needed to acquire water rights. Similarly, rafting outfitter associations are beginning to look at market arrangements to support their water-related interests.

Another important concern regarding market-oriented water transfers is their potential impact on third parties. While water marketing holds promise of aggregate economic and environmental benefits, this does not exclude the possibility of negative consequences for some areas, including rural communities in the arid West.[193] It will therefore be essential for changes in state and Federal law to provide adequate protection for such third-party interests, while facilitating voluntary exchanges of water or water rights.

An important group of potential losers from voluntary water transfers are those whose jobs depend upon agricultural production in areas away from which water would flow as a result of the exchanges.[194]

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[190]The difficulty of depending solely upon market-oriented approaches for all water quantity and quality problems suggests that the ultimate set of policies may involve a mix of market and more conventional regulatory processes. 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): 325-356.

[191]To help provide instream flows in Boulder Creek, Colorado, for example, the Nature Conservancy purchased an irrigation water right in the Berkeley Ditch and conveyed this right to the Colorado Water Conservation Board, the agency that administers the state's instream flow program. Also, Pittsburgh and Midway Coal Company donated to the Conservancy a conditional water right for the Gunnison River in Colorado which the Conservancy then turned over to the Conservation Board to protect flows in the Black Canyon reach of the river. Other examples abound. See: Wigington, Robert. *Update on Market Strategies for the Protection of Western Instream Flows and Wetlands.* Boulder, Colorado: Natural Resources Law Center, June, 1990.

[192]It should also be noted that transferring a water right from a use upstream to a use downstream, even without any changes in water quality, can have significant environmental benefits in terms of additional instream flows between the old and the new diversion points.

[193]See: Oggins, Cy R. and Helen M. Ingram. *Does Anybody Win? The Community Consequences of Rural-to-Urban Water Transfers: An Arizona Perspective*. Udall Center for Studies in Public Policy, University of Arizona, Tucson, May 1990.

[194]Farmers themselves, of course, are *better* off, since the transfer is voluntary.

For example, if farmers sell water to municipalities, they may plant less than they normally would; this would mean that less seed and fertilizer would be required, farm machinery would be in less demand, as would the services of those who pick crops. Presumably they would not benefit directly -- or at all -- from the revenues the farmers reap from having sold their water rights. These parties, then, might be expected to look upon water markets with less enthusiasm than others.

To the extent that these losses are borne by migrant farm workers, the burdens would be falling on some of the most economically disadvantaged members of society. On grounds of distributional equity, then, a case could be made for mitigation. On the other hand, it is most likely that lower-valued, less labor-intensive field crops would first be phased down. And what about the less subtle losses associated with actual third-party impacts, such as an instream user whose flow is severely reduced as a result of an upstream water rights transfer? Obviously, compensation *is* warranted in this case, although it should be recognized that protection for such third parties to water transfers is already provided by state laws.

Interest in water marketing and developments along these lines are almost certain to continue. Collectively, they offer a valuable means of fostering a shift in western water uses to new, environmentally beneficial purposes. Clearly, there is broad and strong public support for environmental protection and for protection of related water resources. Markets can help to accomplish these objectives.

ELIMINATING BELOW-COST TIMBER SALES ON NATIONAL FORESTS

The public lands of the United States, which encompass more than 600 million acres, 25% of the nation's entire land base, include mountains, plains, forests, grasslands, deserts, canyons, wetlands, lakes, rivers, seashores, and islands. The Federal lands contain valuable natural resources, such as timber, hardrock minerals, coal, oil and gas, and forage for livestock, all of which are highly valued (and priced) in the market place. Just as importantly, these lands also hold an immense treasure which is less readily measured in financial terms -- wilderness, fish and wildlife and their habitats, watersheds, free-flowing rivers and streams, scenic beauty, outdoor recreational opportunities, and untapped scientific information. Because a market economy makes it difficult for individual landowners to turn these values into profits,[195] the burden of providing such "environmental amenities" falls disproportionately on public lands.

Providing for these amenities on public lands, however, has been impeded by environmentally damaging and costly subsidies that benefit a few extractive industries. Below-cost timber sales -- where the U.S. Forest Service does not recover the full cost of making timber available -- provide a major example. These subsidies have promoted excessive timber cutting, leading to substantial loss of habitat and damage to watersheds. Gradual removal of these subsidies would foster environmental protection and could save

[195]This is gradually changing in some sectors. For example, cattle ranches are increasingly involved in the leasing of hunting rights.

taxpayers up to $1.2 billion over five years.[196] We now investigate policy mechanisms to implement such reforms.[197]

The Problem of Below-Cost Timber Sales

In the 1960's and 1970's, Congress passed laws establishing the Forest Service's policies of pursuing sustained yields and multiple-use management, the latter referring to the use of National Forests for timber, recreation, wildlife habitat, and watershed purposes.[198] Further, the National Forest Management Act of 1976 explicitly directed the Forest Service to consider economic factors in identifying lands not suitable for timber production.

Despite these intentions, neither the Forest Service nor the Bureau of Land Management (the two principal agencies managing forests on public lands) are under legal or regulatory requirements to sell the public's timber at a price that will recover the government's costs of growing and marketing that timber, and in fact, a substantial amount of publicly-owned timber is sold "below cost." That is, under current Federal policy, the commercial activity of moving timber from public lands into the marketplace frequently costs Federal taxpayers significantly more than they get in return.

The Forest Service's disregard of timber-production costs has led to extensive road-building and excessive logging in unproductive National Forests.[199] In 1989, 102 of 120 National Forest units operated below-cost timber programs,[200] costing Federal taxpayers approximately $365 million (Table 4-2)

[196]See: U.S. Congressional Budget Office. *Reducing the Deficit: Spending and Revenue Options.* Washington, D.C., February 1990.

[197]The following sections in this chapter draw, in part, upon a paper prepared for Project 88/Round II by Peter S. Emerson, "Solving the Below-Cost Timber Sale Problem."

[198]See: Bowes, Michael D. and John V. Krutilla. *Multiple-Use Management: The Economics of Public Forestlands.* Washington, D.C.: Resources for the Future, 1989.

[199]See: Repetto, Robert and Malcolm Gillis, eds. *Public Policies and the Misuse of Forest Resources*. New York: Cambridge University Press, 1988; and Hyde, William F. "Timber Economics in the Rockies: Efficiency and Management Options." *Land Economics* 57(1981):630-37.

[200]O'Toole, Randal. "TSPIRS Revisited: Recalculating the 1989 Figures." *Forest Watch* 10(1990):1-4; and Rice, Richard E. *National Forests: Policies For the Future, Volume 5 -- The Uncounted Costs of Logging*. Washington, D.C.: The Wilderness Society, 1989.

Table 4-2: Net Return to U.S. Treasury from Forest Service Timber Program, 1989

Region	Above-Cost Forest Units		Below-Cost Forest Units	
	Number of Units	Net Return	Number of Units	Net Return
Northern	0	0	13	- $72,642,000
Rocky Mountain	0	0	12	- $20,932,000
Southwestern	0	0	11	- $18,183,000
Intermountain	0	0	16	- $26,190,000
Pacific Southwest	5	$17,611,000	13	- $55,920,000
Pacific Northwest	12	$170,047,000	7	- $53,920,000
Southern	0	0	15	- $48,618,000
Eastern	1	$3,176,000	13	- $34,096,000
Alaska	0	0	2	- $34,976,000
Total National Forest System	18	$190,834,000	102	- $365,163,000

Source: U.S. Forest Service. Treasury receipts from statements prepared by administrative regions; and Forest Service Timber Sale Program Information Reporting System, work sheets on file in Washington, D.C.

. Below-cost timber sales are pervasive in the National Forests throughout the Rocky Mountains and in the arid West, Alaska, and the eastern United States. Indeed, only one management unit outside of California, Oregon, and Washington -- the Allegheny National Forest in Pennsylvania -- made a positive contribution to the Treasury. Forty-eight forests returned less than 10 cents to Federal taxpayers for every dollar Congress appropriated to the timber program.[201]

Perhaps the most frequently stated justification for below-cost timber sales is that they foster community stability. In many parts of the West, Federal timber sales are crucial to local timber industries; these sales provide jobs and related economic benefits. In addition, revenues from sales are shared with local governments, and in many instances are an important component of local road and school budgets. But, as every recession has demonstrated, the availability of Federal timber alone -- even below-cost timber -- is no guarantee of community stability. It is inevitable that the domestic timber industry will continue to experience

[201]These figures differ from the Forest Service's less drastic findings about the prevalence of below-cost timber sales for two reasons: first, the Forest Service amortizes road and reforestation costs over an average of 112 years (1,743 years in the case of one National Forest); and second, nearly 50% of reported Forest Service receipts are retained to pay for reforestation and other activities.

substantial shifts in employment, resulting from broad economic factors (such as changing interest rates, exchange rates, and business cycles), from labor-saving technological changes in logging, milling and transporting, and from the gradual migration of the timber industry to regions of higher productivity. Federal below-cost timber sales cannot overcome these pervasive forces, but they do impede the necessary process of adjustment.

Current and Proposed Federal Policies

The existing Federal timber sale program plays an important role in the national timber market. In 1989, the government sold 13 billion board feet of timber, accounting for about 15% of all domestic logging. In a typical year, the Forest Service and Bureau of Land Management offer a total of 250,000 to 300,000 individual timber sales, ranging in value from a few hundred dollars to several million dollars. For a given tract, an agency's advertised price -- the minimum acceptable bid -- is established by a prior appraisal of the timber. Once the timber is appraised and advertised, bids are accepted, and the sale is awarded to the highest bidder. The advertised price does not, even in principle, reflect the Federal government's cost of providing timber to the market.

While the Forest Service is directed to undertake detailed timber appraisals and to earn "fair market value," it is under no legal or regulatory obligation to sell the public's timber at a price that will recover the government's costs of growing and marketing the timber. Typically, the timber is priced as if it were already physically accessible, but frequently it is not, and the Forest Service ultimately has to pay to build the roads to access the timber which it sells. The high cost of building the roads is not reflected in the advertised price, and frequently is greater than the bid for the timber itself. Indeed, if the Forest Service were a private firm, the value of its assets would place it among the top five of the *Fortune* 500 list of largest corporations, while in net income terms it would be classified as bankrupt.[202]

In response to widely-expressed concerns, the Administration and the Congress have considered several initiatives to deal with the below-cost timber sale problem. For example, the President's budget for fiscal year 1991 included a Below-Cost Commercial Timber Sale Pilot Test to evaluate the implications of phasing out a small set of below-cost timber sales to determine whether the loss in local economic activity and revenues can be offset through the expansion of recreational programs. Other proposals Congress has considered include: reducing Federal spending by phasing out below-cost sales over a five year period; increasing reliance on the timber market to determine the annual harvest level in Alaska's Tongass National Forest; and funding operations of each National Forest from a share of that forest's *net* income from timber sales. Each of these initiatives has its advantages and disadvantages. Overall, they each direct more attention to economic considerations in selling and managing Federal timber.

Overview of Approaches to Eliminating Below-Cost Timber Sales

Federal timber sales link road building, land management services, and annual payments to state and local governments to the activity of logging. These links create budgetary and political incentives for continued (and expanded) timber operations, even on money-losing sites. These incentives are of great

[202] See: O'Toole, Randal. *Reforming the Forest Service*. Washington, D.C.: Island Press, 1988.

significance because they are the most important forces that block efforts to solve the below-cost timber sale problem.

Since 1905, when Congress transferred the forest reserves to the Department of Agriculture and created the Forest Service, a driving objective has been to achieve an even distribution of timber stands among different age classes -- as rapidly as possible. To achieve this objective, deposits from timber buyers are retained by the Forest Service for reforestation and brush disposal, 10% of gross timber receipts are earmarked for constructing and maintaining roads and trails, and credits are given against timber payments for purchaser-built roads. Such earmarked funds based on the number of acres logged and gross timber receipts make up a substantial portion of the Forest Service's budget. As such, they encourage the agency's managers to use timber sales to perpetuate development of the forest. Even timber sales which are net losses for taxpayers contribute to a manager's budget.

This system has fostered vested bureaucratic and political interests for continuing high timber-harvest levels, both within and outside of the Forest Service. Forest industry firms, workers, and local communities have all become dependent on National Forest timber harvests, creating a set of strong constituencies for more logging. It is important to modify the existing system so that public-land managers and others face incentives which reflect the full social value of forests. At a bare minimum, this would mean making forest management decisions according to sound financial criteria. At private firms, sales which fail to cover their costs simply are not tolerated. Yet a principal justification for Federal ownership of forests is that the government can exercise better stewardship over the environmental amenities that private firms have trouble incorporating. Therefore, incentives should go beyond the purely financial criteria of comparing revenues with outlays where high-value environmental (non-financial) uses are sacrificed through logging. As noted earlier, such uses would include, but not be limited to habitat protection, watershed values, and biological diversity. What is needed is a set of self-enforcing inducements to protect and enhance the *full social values* of individual forests.

Designing New Policies

The overview provided above noted two key elements of a desirable incentive system for National Forest management: the incentives faced by Forest Service managers and the incentives faced by localities which receive funds from Forest Service sales. We now focus on each in turn.

(1) Decentralized Management of Self-Financed National Forests

A major step toward improving the incentive structure facing the Forest Service would be to decouple forest management decisions from centrally-determined production targets and appropriations by funding activities on each forest -- to the extent possible -- from net receipts earned on that forest.[203] This approach would eliminate many of the perverse incentives that reward forest managers for losing money on timber sales and for ignoring some production costs in their decision making. This system could be structured around specific management objectives for different classes of forest lands. The system should begin by separating

[203]For an analysis of how to implement such an approach to forest management on public lands in the U.S., see: O'Toole, Randal. "Testing New Incentives on Selected National Forests." C.H.E.C. Oak Grove, Oregon, 1990.

out lands unsuitable for timber production. While such a provision is already a part of the National Forest Management Act of 1976, its implementation has not been satisfactory. Forests designated as suitable for timber harvesting would be run in an efficient and business-like manner, charging market prices and paying market costs. The Forest Service would not set timber targets for each forest; rather, each forest manager would take actions intended to maximize net revenues from the specific forest-resource asset base.

Critical to the success of such a system is allowing forest managers to capture revenues from timber *and* non-timber uses of the forest. The current system is fundamentally flawed in its near absolute dependence on timber sales for revenue. By some estimates, timber may represent only 25% of the value of forests, but timber sales generate more than 80% of revenues. On the other hand, recreation represents 41% of gross forest value[204] and is thus the single most valuable use, but it generates only 3% of forest revenues (Table 4-3). Other potential activities from which a forest manager could generate revenues would be grazing rights, oil and gas, and mineral resources.

Table 4-3: Annual National Forest Resource Values, Receipts, and Costs

Resource	Estimated Value		Receipts		Costs	
	Amount (millions)	Share	Amount (millions)	Share	Amount (millions)	Share
Recreation	$1,393	41%	$31	3%	$121	10%
Timber	$919	27%	$917	82%	$965	89%
Minerals	$585	17%	$161	14%	$27	1%
Fish & Wildlife	$400	12%	0	0%	$37	3%
Water	$81	2%	0	0%	$32	3%
Grazing	$56	1%	$9	1%	$32	3%
TOTAL	$3,434	100%	$1,118	100%	$1,213	100%

Source: O'Toole, Randal. *Reforming the Forest Service*. Washington, D.C.: Island Press, 1988. (Data from U.S. Forest Service)

In addition to efficiency arguments, there are also strong equity arguments for making each use pay for itself. Timber consumption is not a public good; all benefits are purely private. Hence, Federal law states that timber buyers should pay fair market value. The same should be expected for other private forest uses. Recreation benefits, for example, arguably accrue to those who can afford to pay for them. Yet recreation

[204]This estimate of recreational value is from studies by the U.S. Forest Service of total willingness-to-pay by visitors to National Forests. It is based upon contingent-valuation and other standard methods of estimating the economic benefits of recreational opportunities.

users received a $90 million subsidy in 1985. There is certainly substantial precedent for the notion of users of publicly owned natural resources paying for benefits they derive.[205]

Many environmental benefits are hard to translate into cash receipts through conventional market mechanisms. Likewise, many citizens value the existence of wilderness who may never visit the forests. For both sets of benefits, it is difficult to implement any form of direct charge. Therefore, an important Federal role would be to provide funding to individual forests for protecting these amenities. Such funds could come from a portion of aggregate net receipts earmarked for the purpose.

(2) Improving the Basis for Local Payments

The second element of a desirable incentive system for National Forest management is associated with payments to local communities.[206] Receipts from timber sales on National Forests are shared with counties because Federally owned lands are not taxable and because local governments therefore may need financial assistance to provide services to those lands. Because property taxes are the primary revenue source for county governments, these forgone taxes in counties with National Forests can be significant. In addition to forgone taxes, Federal lands can impose expenses on neighboring local governments, such as for road maintenance, police, and hospital services. At the same time, however, the presence of National Forests can relieve local governments of some responsibilities. For example, roads in National Forests, which may be used by local residents, are fully financed by the Forest Service.

Currently eight programs share revenues from the sale of natural resources on Federal lands with local (state or county) governments.[207] The National Forest Revenue Act of 1908 (NFRA) is the oldest (natural resource) revenue-sharing program. Payments under NFRA in 1988 to 650 affected counties (in 42 States and Puerto Rico) totalled $318 million.[208] In 1976, the Payments In Lieu of Taxes program (PILT) was enacted to deal with the instability and single-use bias of the existing Forest Service compensation program. The PILT program guarantees a minimum annual payment to local governments of 75 cents per acre for qualified public lands. Although the original intention was to substitute the PILT program for NFRA and other programs, it wound up as a supplement. Since 1976, Federal law has required that 25% of *gross*

[205]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.

[206]This section of the chapter draws upon a paper prepared for Project 88/Round II by Michael Cameron, "Sharing Timber Receipts with County Governments: Current Problems and Possible Reforms."

[207]There are, in order of magnitude in 1984: oil and gas leasing; national forest revenues (NFRA); payments in lieu of taxes (PILT); public land revenues (BLM); coal leasing; land and water conservation fund; nonfuel minerals leasing; and geothermal leasing. See: Fairfax, Sally K. and Carolyn E. Yale. *Federal Lands.* Washington, D.C.: Island Press, 1987.

[208]Due to variations in timber values and logging activity, payments per county varied from zero to $29.6 million. Counties in Oregon, California, and Washington received more than 75% of the total payments.

timber receipts be allocated to state and county governments.[209] The combined result of these programs is that counties are guaranteed a minimum Federal payment of 75 cents per acre of National Forest, subject to a ceiling based on county population. Recent studies indicate that as a consequence, phasing out below-cost timber sales would, in fact, have little or no impact on Federal payments to counties.[210]

Nevertheless, the fear that elimination of below-cost timber sales will cut Federal payments to counties is pervasive, and by tying receipts-sharing with counties to the level of timber cut, the program has given counties a motivation for supporting high levels of timber harvesting, without regard to sound forest-management principles. The program thus contributes to overcutting on the National Forests. Furthermore, severe annual fluctuations in payment levels often impose fiscal hardships on local governments. The program exacerbates the already cyclical nature of local-government finances in timber-dependent regions of the country. The timber industry follows general cycles of economic activity. Because Federal timber sales are tied to the timber market, payments to counties tend to be procyclical. Thus, at those times that (timber) recessions cause losses in jobs, and erode state and local tax bases, Forest Service payments to local governments from the Forest Service also decline. Because the timber market tends to be extremely volatile, fluctuations in Federal payments are severe. What is needed is a local compensation program that is more reliable and encourages better use of diverse forest resources.

The payment that a given county receives in any year is a function of gross timber receipts from the National Forest within its jurisdiction, not from the National Forest system as a whole. For the most part, the variability of payments to individual counties is greater than for the system as a whole. Payments to individual counties would be more stable if they varied only as much as the aggregate. One method of tying individual payments to aggregate payments, without redistributing payments among counties, would be to pay each county a fixed share of total Federal payments. These county payments could be linked to *all* Forest Service receipts, not just those coming from timber sales.

The system could work as follows: local forest managers would turn over a portion of their net revenues to the Forest Service, which would then pay a share to each county. The size of the share might be its average historical share of the national total.[211] An advantage of this system is that it would decrease the annual variance in payments for the typical county. Thus, the fixed-share method would serve as insurance against bad years on their National Forests. The fixed-share method would also reduce incentives for localities to push for increased timber sales, since an increase in timber activity within a given jurisdiction would, in the short run, be shared by all 650 counties in the National Forest system. Linking payments to both timber and non-timber forest uses would also create incentives for county governments to promote a more socially optimal mix of forest uses.

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[209]When net receipts are less than 25% of gross receipts, payments are funded out of general revenues or are subsidized by "profitable" timber sales in other parts of the country.

[210]See: Emerson, Peter. "Solving the Below-Cost Timber Sale Problem." Discussion Paper. The Wilderness Society, Washington, D.C., August 1990.

[211]Because future sales patterns will not perfectly mimic those of the past, the share paid to each county would have to be periodically updated to reflect the actual share of timber sale receipts collected from within each county. This would need to be adjusted, of course, for non-timber, as well as timber values.

An alternative to the above system would be one in which the flow of funds remained at the local level, but payments were made on the basis of the asset value of the land, not annual receipts. In essence, the Forest Service would make payments on the basis of the quantity and quality of all services of the total forest area. Elements of such a system are already in place, since the PILT program guarantees 75 cents per acre for qualified lands, should receipts fall below a benchmark level. The level of payment might vary according to both the classification of the forest and the equivalent property taxes paid by private forest owners. Payments would be made by individual National Forests directly to state and county governments, and would appear as line items on forest operating statements in the same way that long-term lease or tax payments might appear for a private firm. This approach would remove incentives for localities to argue for short-term gains from uneconomic timber harvests.

Addressing Equity Concerns

If below-cost timber sales were to be eliminated, the losers would be relatively easy to identify: they would be the loggers who are currently employed harvesting timber on Federal lands, the private construction companies that build the roads that support this harvesting, those who supply equipment and other goods or services to these logging and construction companies, workers who process this timber, and local governments which receive a share of receipts from sales. If less timber were harvested, they could be expected to suffer even though Federal taxpayers as a whole would benefit economically and environmentally.

Is compensation merited in this case? Putting aside for the moment the local-government-finance issue, the case for compensation to individuals and firms is difficult to make, at least on equity grounds. It would require demonstrating that the Federal government has an obligation to those who have in the past benefitted from a money-losing enterprise. Logging companies did not start up operation explicitly in response to an announced policy of below-cost timber sales by the government. Furthermore, a suspension of below-cost sales would not be a precipitous and wholly unexpected policy change. This, too, weakens the case for compensation.

Next, what about the lost revenue to local governments which have come to depend upon shared timber-sale receipts? The evidence here suggests that compensation to local governments, as opposed to private parties, for a reduction in timber-sale receipts *is* properly justified. The justification for sharing Federal revenues is based partly on the fact that local governments must provide services due to the presence of Federal lands which are not taxable. The current method of providing compensation through revenue sharing from timber sales, however, is based on a very *rough* measure of *one* economic value of the forest land -- namely, timber production. By being linked to *gross* receipts of one of the multiple uses of forests, the revenue-sharing arrangement provides a perverse incentive for localities to support excessive logging levels. In addition, the system imposes a cost on local governments due to large annual fluctuations in revenue due to variations in timber sales.

A second justification for compensation is based upon the costs imposed on local governments by the presence of nontaxable Federal lands in their jurisdictions. If these lands were privately owned, they would be taxable, based on their value. In effect, the harm to local governments results from these lands being in the public domain rather than the private sector. Fairness in this case would suggest that compensation be based on the loss of taxable economic value to local jurisdictions, which is precisely the approach outlined here

-- modifying the basis for sharing revenues with local governments to compensate for the multiple economic values of these lands.

Summary

The below-cost timber sale system can be changed to yield greater benefits to those who are most affected by it. Non-timber consumers of National Forests who are disadvantaged by excessive logging, county governments that cannot budget forest payments with confidence, and forest managers who face perverse incentives all stand to gain from improvements to the system. The political support of these interest groups, which often have been at odds in the past, is critical for meaningful reform to occur. The selection of any alternative policies, therefore, should be sensitive both to the efficacy of respective policies and their acceptability to relevant parties.

An important step toward improving the incentive system currently faced by Forest Service managers would be to sever forest management decisions from centrally-planned production targets and appropriations. This could be accomplished by financing activities on individual National Forests from net receipts earned on those forests, thus eliminating the perverse incentives which reward forest managers for losing money on below-cost timber sales. Such a system should make forest managers sensitive to *net* revenues from timber *and* non-timber uses of the forest.

With regard to the basis of calculation of local revenue-sharing, several reforms merit consideration. Either the fixed-share or the asset-based payment method could be used to address the local-finance and resource-management issues. The basis for calculation should be changed from gross to net receipts, and should include as broad a range of forest uses as feasible. While the gross receipts method may provide counties with extra revenues, it contributes to the inefficient management of the forests. To offset any decline in revenues, new revenue sources should be created -- up to $74 million annually to make up for losses due to eliminating below-cost timber sales. Over time, non-timber revenues could increase until each source contributes revenues in proportion to the value it adds to National Forests.

In the 80 years since receipt-sharing began, the role of National Forests and the rules governing their management have changed dramatically. The method for sharing receipts has not kept pace. The system adversely affects the management of forest resources and is not serving its primary constituent, county governments, well either. There are no compelling reasons why the current receipt-sharing system cannot be improved. In the long run, all parties stand to gain.

CHAPTER 5
EFFICIENCY, EQUITY, AND THE POLITICS OF MARKET-BASED ENVIRONMENTAL POLICIES

Many environmental and resource policy proposals -- whether conventional command-and-control or incentive-based -- involve some tradeoff between efficiency and equity. Although we examine the

efficiency and equity impacts of alternative policy mechanisms throughout the study, in this chapter we investigate the possibility of resolving this tension by combining feasible, cost-effective environmental policy reforms with adjustment packages designed to mitigate associated equity problems. To provide a context for this discussion, we begin by reviewing the major incentive-based policy mechanisms investigated in the study. After our discussion of designing policies to include equity considerations, we offer some concluding comments regarding the future role of market-based policies for natural resource management and environmental protection.

AN OVERVIEW OF MAJOR INCENTIVE-BASED POLICY MECHANISMS

Conventional command-and-control regulatory mechanisms can be usefully supplemented by incentive-based approaches to environmental protection and natural resource management. Five general categories of policy instruments are promising: pollution charges, tradeable permit systems, deposit-refund systems, removing market barriers, and eliminating government subsidies. The choice among alternative policy instruments will be made on the basis of broader criteria of what constitutes good public policy.[212]

This study has identified a dozen policy mechanisms by which we can address environmental and resource problems within three broad problem areas: global climate change, solid and hazardous waste management, and natural resource management (Table 5-1). For the reasons spelled out in previous chapters, these twelve incentive-based policy proposals merit serious consideration, but only within the context of well-defined problems. We need to develop a clear understanding of the problems we face before we begin our search for appropriate tools of public policy.

IMPLEMENTING INCENTIVE-BASED POLICIES: THE ROLES OF ADJUSTMENT, MITIGATION, AND COMPENSATION

As we have emphasized throughout this report, the choice of appropriate environmental policies depends on considerations of equity as well as cost-effectiveness. A market-oriented approach cannot avoid one problem that attends any policy change: some affected parties may end

[212]As discussed in Chapter 1, environmental and natural resource policies can be assessed in terms of cost-effectiveness, equity, flexibility, and feasibility, among other criteria.

Table 5-1: Incentive-Based Policy Mechanisms for Major Environmental and Resource Problems

Problem Area	Specific Policy Problem	Incentive-Based Policy Mechanisms
GLOBAL CLIMATE CHANGE	How can national greenhouse targets be cost-effectively reallocated among countries, subsequent to international negotiations?	International trading in greenhouse gas source/sink permits
	How can internationally mandated domestic greenhouse targets be cost-effectively achieved in the U.S.?	CO_2 charges (carbon charge, BTU charge) Domestic trading of greenhouse gas permits
	What actions could the U.S. undertake without waiting for international agreements or further research results?	Comprehensive environmental least-cost bidding and planning at electrical utilities
SOLID AND HAZARDOUS WASTE MANAGEMENT	Insufficient capacity at landfills and incinerators for existing volumes of municipal solid waste.	Unit charges for curbside pickup and collection (with possible differential pricing for specific, separated recyclables)
	Social disposal costs (health, ecological, and aesthetic impacts) associated with specific products in excess of volume-related costs (and/or unit charges are impractical).	Retail disposal charges
		Virgin material charges
		Deposit-refund system
	Improve cost-effectiveness of programs using recycled-content standards.	Recycling credits (recycling targets combined with tradeable permits)
	Need to identify new sites for facilities for ultimate disposal and recycling (NIMBY).	Local binding referenda linked with negotiated mitigation package
NATURAL RESOURCE MANAGEMENT	Increase efficiency of water use to reduce demand for new dams and reservoirs and to protect environmental quality.	Water markets for voluntary exchanges
	Protect public lands from uneconomic timber cuts, save taxpayers money, and continue to provide compensation to localities.	Eliminate below-cost timber sales on national forests (and provide payments to localities based on true economic value of all forest uses)

Note: The policy problems and incentive-based policy mechanisms are explained in Chapters 2 (Global Climate Change), 3 (Solid and Hazardous Waste Management), and 4 (Natural Resource Management).

up worse off than they were before. Furthermore, the implementation of economic-incentive policy mechanisms will tend to focus attention on the tradeoff between efficiency and equity.[213] Because of the important ethical concerns surrounding these issues and because of their great importance in the real world of environmental politics, these tradeoffs cannot be ignored. Under some circumstances, it may be desirable to design policy packages that include measures to mitigate outcomes which are perceived to be inequitable.[214]

Why Provide Adjustment, Mitigation, or Compensation?

There are several possible reasons for offering some kind of compensation to those affected by an environmental policy. First, and most pragmatic, is the consideration that the potential losers from a particular policy change may have the power to prevent it.[215] The losers are particularly likely to be able to block change if they are easily identifiable and well organized, and if the gainers are widely distributed and less well-organized.[216] In such situations, it may be necessary to offset part of their losses to build political consensus.

Second, equity considerations may suggest providing compensation. To take an extreme example, suppose a particular policy change (for which aggregate benefits would exceed aggregate costs) would provide very small per capita benefits to a very large number of people, while all its costs would fall on a small group of relatively poor people (building a freeway through a low-income neighborhood, for instance). Even if total benefits to society exceeded total costs by a wide margin, many citizens would be uneasy about proceeding with the project. Adjustment, mitigation, or compensation might be attractive options.[217]

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[213]For comparisons of incentive-based and conventional environmental policies in terms of their differential equity impacts, see: Buchanan, James and Gordon Tullock. "Polluters' Profits and Political Response: Direct Controls Versus Taxes." *American Economic Review* 65(1975):139-147; Dewees, Donald. "Instrument Choice in Environmental Policy." *Economic Inquiry* 21(1983):53-71; Harrison, David Jr. and Paul R. Portney. "Who Loses from Reform of Environmental Regulation?" *Reform of Environmental Regulation*, ed. Wesley A. Magat. Cambridge, Massachusetts: Ballinger, 1982; Leone, Robert A. and John E. Jackson. "The Political Economy of Federal Regulatory Activity." *Studies in Public Regulation*, ed. G. Fromm. Cambridge, Massachusetts: MIT Press, 1981; and Hahn, Robert W. "The Political Economy of Environmental Regulation: Towards a Unifying Framework." *Public Choice* 65(1990):21-45.

[214]This part of the chapter draws, in part, upon a paper prepared for Project 88/Round II by Dallas Burtraw and Paul R. Portney, "Implementing Market-Based Environmental Policies: The Role of Compensation."

[215]Providing compensation can make it much easier to get reform enacted. See: Tullock, Gordon. "Achieving Deregulation - A Public Choice Perspective." *Regulation*, November/December, 1978, pp.50-54.

[216]Olson, Mancur. *The Logic of Collective Action*. Cambridge, Massachusetts: Harvard University Press, 1968.

[217]The mere existence of "losers" does not justify compensation. On the contrary, the "equity justification" has substantial force only when those who are hurt by an efficient policy belong to a particularly disadvantaged group in society.

An Overview of Potential Adjustment Mechanisms

Adjustment mechanisms have often been used for policy changes. For example, when -- in the interests of free trade -- the U.S. has eliminated protective tariffs or import quotas, "trade adjustment assistance" has sometimes been provided, including extended unemployment compensation for workers who may lose their jobs as a result of the policy revision. Similarly, compensation has been offered to people whose homes were torn down to make way for new highways or other rights-of-way in urban areas. Assistance has also been given to workers who lost their jobs because their industry was deregulated to increase economic efficiency. (Airlines provide a recent example.)

(1) Implicit and Explicit Adjustment and Compensation

To the extent that they cost less than command-and-control regulations, market-based incentives provide savings that can be used to fund mitigation or compensation. For instance, the total cost of our attempts to reduce acid deposition can be minimized by using market-based policies. Under a tradeable-permit pollution-control program, the initial allocation of emission permits can be designed to favor (implicitly compensate) those firms that would otherwise suffer the greatest losses. Compared with a uniform-standard approach to pollution control, marketable permits generate efficiency gains that can help compensate those who are harmed by a regulation.

The proposed international tradeable permit system for greenhouse-gas sources and sinks also allows for implicit compensation. The initial allocation of permits can be designed to relieve much of the financial burden on developing nations. In this way, the industrialized countries would essentially be subsidizing cost-effective control measures in the developing world.

Sometimes, however, explicit compensation may be necessary, as in the siting of waste management facilities. In negotiating an agreement with a developer, virtually any host community will insist on compensation of some kind. Such arrangements are illustrated by our policy proposal for linking mitigation packages with binding local referenda.

(2) Linked Adjustment and Compensation

Compensation need not take the form of monetary payments to those harmed by a prospective policy change, and in fact, such payments may be a less appropriate form of mitigation or compensation. Adjustment mechanisms directly linked to the type of harm imposed by a policy change are likely to be more readily accepted and may cost less than cash compensation. Understanding what level of compensation is appropriate for accepting a hazardous waste facility in one's community is difficult, because the calculation involves tradeoffs in multiple dimensions -- time, income, property values, and health risks. Tradeoffs along a single dimension are easier to calculate and may provide more consistent answers. Thus, if a hazardous waste facility reduces property values in a community, this injury could be offset by the dedication of amenities (for example, open space) that bolster property values. This "linked" adjustment and compensation approach validates community concerns, reflects a willingness to compromise on the part of policy makers,

and avoids a host of troublesome issues, such as how to distribute cash compensation and whether it will disproportionately accrue to certain individuals or groups.[218]

Other forms of linked compensation could respond to other community concerns. For example, if citizens are worried about possible health effects, compensation may take the form of subsidies for health care for local residents, community-financed improvements in drinking water quality, or other measures aimed directly at improving human health.

(3) Choosing the Appropriate Baseline

In designing any adjustment or compensation package, it is important to consider the baseline against which a policy change is being measured. In the case of a proposed ban on mineral extraction, for example, it makes a difference whether the restriction applies to a wilderness area that has never been mined or to an area in which mining has been carried on for some time. Similarly, if we decided to implement a carbon charge or tradeable CO_2 permits, we need to consider whether compensation should be judged against a baseline of no regulation, or a traditional command-and-control approach to the problem of potential climate change. In considering hazardous waste management, should economic incentives be set in relation to a situation of no regulation, or to the existing rules under RCRA and Superfund?

Consider the evolution of the recently enacted Clean Air Act amendments dealing with acid rain.[219] If the new regulation is compared with the current baseline of no policy at all, the losers would be the electric utilities, their shareholders, and ratepayers who would bear the costs of controlling sulfur dioxide emissions.[220] But, if losses are measured against command-and-control regulation -- especially technology-based standards such as mandated installation of scrubbers -- then a different set of actors would appear to be hurt by market-based approaches. In this case, electricity consumers and corporate shareholders would benefit (because they would pay less for pollution control than under baseline conditions), while the losers would be miners of high-sulfur coal, since the market for their product would shrink.[221] In other words, the baseline makes a big difference in thinking about whether and how to adjust for the effects of policy changes.

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[218]The costs of linked compensation may be less than comparable monetary expenditures because of public-good aspects of compensation. For instance, if a company locating a hazardous waste facility provides open space as compensation to the community, the company itself may benefit from the associated increase in property values in the community. In contrast, monetary compensation to affected residents does not generate a public good.

[219]For a brief overview of the concept of "acid rain reduction credits," see Chapter 3 of the first Project 88 report; a more detailed description and analysis is provided by: Bohi, Douglas R., Dallas Burtraw, Alan J. Krupnick, and Charles G. Stalon. "Emissions Trading in the Electric Utility Industry." Discussion Paper QE90-15. Washington, D.C.: Resources for the Future, 1990.

[220]Obviously, there is a large and important set of winners, too -- those who are harmed in a variety of ways by current acid deposition. We concentrate on the losers because our interest here is in adjustment issues.

[221]This potential problem was addressed in 1990 by the Congress when it reauthorized the Clean Air Act. In separate legislation, a program was established to provide job-training and other forms of compensation for workers displaced by the new law, at an estimated cost of $250 million over the next five years. See: Schneider, Keith. "Lawmakers Reach an Accord on Reduction of Air Pollution." *New York Times*, October 23, 1990, pp. A1, A18.

The Roles of Adjustment, Mitigation, and Compensation in the Design of Market-Based Policies

Throughout this study, we have identified the principal equity considerations associated with each policy mechanism and suggested ways to address these equity concerns through policy adjustments, mitigation, or actual compensation. Table 5-2 summarizes this information for the three major problem areas we have addressed.

Although market-oriented mechanisms provide a kind of implicit compensation in that they cost less than would traditional command-and-control regulations, it may be appropriate in some instances to compensate those who are harmed by the introduction of new policies. Where -- for reasons of equity, efficiency, or political pragmatism -- adjustment is merited, it should be linked whenever possible to the nature of the harm done. That is, if jobs are lost as a result of the policy change, compensation might best take the form of new job opportunities, as opposed to a simple monetary payment.

The strength of the case for adjustment and compensation depends on the specific policy approach that is being considered. The argument is relatively weak when a new regulation brings an environmental cost into the private decision framework. If new and different controls are being layered onto a pre-existing regulatory mechanism, the case may be stronger. As always, general rules are of little use; instead, each specific policy mechanism must be investigated within its relevant setting to determine whether provision for adjustment, mitigation, or compensation ought to be part of the overall policy package.

THE FUTURE ROLE OF MARKET-BASED POLICIES: WHERE DO WE GO FROM HERE?

As we enter the 1990's, policy makers, environmentalists, and private industry all seem receptive to a new, more market-oriented approach to environmental problems. A consensus is emerging that carefully designed economic-incentive programs will often be able to achieve greater environmental protection at lower total cost to society than is possible with command-and-control regulation on its own. A market-based approach can lead both consumers and producers to consider the true costs of their decisions, encourage technical progress in pollution control, save policy makers from sinking into a morass of obscure technical issues, and keep government attention focused on the important issues, such as how much pollution control should be desired.

Table 5-2: Equity Concerns & Policy Responses

Problem Area	Incentive-Based Policy Mechanisms	Potential Equity Concerns	Possible Policy Responses
GLOBAL CLIMATE CHANGE	Int'l Trading in Greenhouse Gas Permits	Developing countries unable to pay for control	Initial allocation of permits on basis of equity considerations
	CO_2 Charges (contingent upon prior international action)	Competitiveness of domestic energy-intensive industries compromised	Charge revenues used to reduce distortionary taxes; charges applied to imported products as well
		Impacts on employees of carbon-intensive fuel producers	Job-search and job-training for displaced workers
	Comprehensive Least-Cost Environmental Bidding	Higher energy prices may impose burden on low-income households	"Life-line" rates for initial increment of energy use
		Possible employment losses at high-polluting energy providers	Job-search and job-training for displaced workers; job matching between firms
SOLID & HAZARDOUS WASTE MANAGEMENT	Better Price Signals (including curbside unit charges)	Higher disposal costs may impose burden on low-income households	"Life-line" rates for initial increment of waste disposal services
		Possible impacts on industries involved with extraction and distribution of some virgin materials	Job-search and job-training for displaced workers
	Recycling Credits	Possible impacts on selected firms involved with regulated materials	Job-search and job-training for displaced workers
	Deposit-Refund Systems	Costs may impose burden on low-income households	Refund component assures that financial losses can be avoided
	Referenda for Facility Siting	Low-income communities may carry burden of hosting new facilities	Referenda gives community ultimate say; linked compensation
NATURAL RESOURCE MANAGEMENT	Implement Water Markets for Voluntary Exchanges	General third-party impacts	Protected under state water laws
		Farm workers may incur income losses or even unemployment	Job-search and job-training for displaced workers
	Eliminate Below-Cost Timber Sales	Loss of revenue for some local governments	System of compensation based on economic value of all forest uses

Our analyses of specific policies for three major problem areas -- global climate change, solid and hazardous waste issues, and natural resource management -- illustrate that translating the broad concepts of market-based environmental protection into practical and effective policy mechanisms will require attention to numerous design issues -- some quite technical, some not. The problems are by no means insignificant, but neither are they insurmountable. With creative thinking, policies and programs can be designed that are effective, efficient, equitable, and truly feasible.

As we emphasize in Chapter 1, however, not all environmental problems are amenable to incentive-based policies. For example, highly localized pollution problems that exhibit significant threshold effects in human-health damages may well call for conventional command-and-control approaches. Furthermore, it is not enough to identify policies that are cost-effective or efficient. Several other criteria must also be considered, including the equity effects of policies -- their differential impacts on various income groups, geographic regions, and sectors of the economy. In this context, it may sometimes be appropriate to include adjustment, mitigation, and compensation mechanisms in new environmental policy packages.

As we have seen, the monitoring, enforcement, and other administrative costs associated with environmental policies -- whether incentive-based or conventional -- can be significant barriers to effective implementation. One must to be able to define and measure changes in polluting behavior and detect undesirable responses to policies, such as illegal dumping. Unless a policy is self-enforcing, enforcement mechanisms to ensure compliance are critical.

Just as command-and-control policies pose a distinctive set of problems, so too do market-oriented approaches. In general, these economic-incentive policies depend upon the existence of well-functioning markets. If the market for tradeable permits is thin, for example, or transaction costs are high, the outcome will be less cost-effective than anticipated. Firms must be able to identify potential trading partners, and regulatory constraints to trading must be minimal. Also, if permit markets are highly concentrated, we may achieve our environmental objectives, but not in a cost-minimizing fashion.

The first Project 88 report recommended the *selective* use of incentive-based policies. Project 88/Round II reaffirms the notion that no single policy approach -- whether market-based or command-and-control -- can solve all our environmental and resource problems. The real challenge is to choose the right policy for each job. Numerous opportunities exist to improve environmental protection and natural resource management with incentive-based policy reforms, but they must be assessed on a case-by-case basis.

This report has explored some promising alternative policies for several pressing environmental problems and offered some specific policy prescriptions, as in the case of implementing water markets and eliminating below-cost timber sales. On other issues, we have suggested alternative policies, with the final choice to depend on preconditions of international action (as for mechanisms to combat global climate change); the results of further investigations (as in the choice between tradeable recycling permits and deposit-refund systems for used lubricating oil); or the specifics of local market conditions (as in the case of unit charges for municipal solid waste management). For these and the other policy proposals examined, we have tried to highlight the major challenges that must eventually be resolved for effective design and practical implementation.

In many respects, the real work lies ahead. Translating these and other good ideas into effective policies will require the active participation of all segments of the diverse environmental policy community. Policy makers -- at the Federal, state, and local levels -- must provide leadership to ensure that these options are given reasonable consideration in the appropriate contexts. Regulators, environmental activists, private industry representatives, and academic researchers can focus on issues highlighted in this report and begin hammering out the specifics of better environmental policies.

Over the past two years, we have witnessed dramatic changes in the political landscape of environmental policy. Legislators, bureaucrats, environmentalists, business persons, and citizens of all kinds have come to recognize that market-based instruments belong in our portfolio of environmental and natural resource policies. But as dramatic as these changes have been, they are only the first steps toward improved environmental policy. While the window of opportunity remains open, we must take up this challenge and continue to move ahead.