Working Paper

The State of the Art in Economic Instruments and Institutions for Water Quality Management

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Abstract

Economic instruments for environmental quality management have received widespread attention in the Central and Eastern European (CEE) countries as a means of achieving improved environmental quality at the lowest cost. This paper describes the economic instruments currently used in water quality management - charges, subsidies and effluent trading, then reviews the experience of Western countries in exercising these policies. The paper further identifies new institutional developments aimed at achieving more effective environmental quality management. Based upon this experience with both instruments and institutions in Western countries, lessons are offered for improving water quality management policy in Central and Eastern Europe.

The State of the Art in Economic Instruments and Institutions for Water Quality Management

Mark Griffin Smith

1. Introduction

The United States and the western European countries control water quality using a variety of instruments and institutions. These tools range from regulatory command and control (CAC) approaches of technological, emissions and ambient standards to economic or incentive-based approaches such as charges, subsidies and transferable discharge permits (TDPs). As the economies of the CEE countries move from central planning to the free market, it is appropriate to review both the literature on and experience with economic instruments for water quality management to understand how they might be applied in that setting. The Central and Eastern European countries face serious water quality problems and the resources needed to address these problems are large (Somlyódy, 1993). The challenge of improving water quality in CEE requires finding cost-effective approaches that are appropriate to the institutional context of individual CEE countries.

The purpose of water quality control is to maintain water quality at desired levels at the lowest possible cost (Kularathna and Somlyódy, 1994). While much has been written by economists about the determination of the optimum or "desired level" of water quality (for example, Feenberg and Mills, 1980; Smith and Desvousges, 1986), the intangible nature of most water quality benefits has meant that, in practice, water quality standards have not been established on the basis of economic criteria. This notwithstanding, economics has made considerable contribution to the identification and evaluation of cost minimizing approaches for water quality management under an exogenously determined set of water quality objectives. This paper reviews both what has been proposed and what has been tried toward the aim of identifying appropriate water quality management policies for Central and Eastern Europe (CEE).

2. First Principles

Economists describe pollution as a "negative externality". Externalities arise when a non-market impact resulting from the consumption or production activity of one economic agent (a person, household, firm, state-run enterprise, etc.) affects the welfare of another economic agent. Untreated municipal sewage is a good example of an externality as its effects can include both impacts on market goods such as fish, non-market goods such as swimming and recreational fishing and publicly provided goods such as drinking water. The important distinction is that the consequence is a non-market or non-priced effect so that the market neither rewards or penalizes its producer.

When economic activity generates pollution as an externality, there are a number of important implications for the market allocation of resources (Tietenberg, 1992):

(1) Too much output is produced.
(2) Too much pollution is produced.
(3) The prices for the pollution generating product are too low.
(4) There are no incentives to look for less polluting means of production.
(5) Recycling and reuse of polluting substances are discouraged because release into the environment is inefficiently cheap.

The misallocation of resources associated with pollution requires some means of "internalizing" the externality so that its producer faces some consequence from its pollution generating activity.

Coase (1960) observed that all externalities are essentially cases in which property rights are undefined. Where property rights are well defined, pollution problems can be resolved either through the market, negotiation or litigation between property owners.[1] In absence of clear property rights government intervention is necessary to correct the failure of the market to efficiently allocate resources when externalities are generated.

The most widespread approach used affect the control of pollution is to set standards based upon abatement technology, effluent levels and/or ambient environmental quality. These standards are then monitored and enforced using fines and penalties. Research has shown that this "Command and Control" (CAC) fails to achieve desired environmental quality improvements at minimum cost (Tietenberg, 1985). Economic instruments provide a means to meet the same objectives at lower cost.

3. Economic Instruments: Efficiency and Equity Properties

The primary argument for economic instruments is efficiency[2], i.e. they achieve

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[1]The common law tradition of England and the United States requires that a party have legal "standing" to seek remedy from the courts for damage from pollution. Standing requires that the affected party can demonstrate loss in the value or enjoyment of their property. Under the common law tradition it is legally impossible for anyone to sue on behalf of "the environment" or "the fish" in an attempt to affect water quality improvements. While it is conceivable that property rights could be granted to make such suits feasible, it is not clear that such a litigious system would be more effective than regulatory and other economic approaches where uncertainty, information and transactions costs are high.

[2]The term efficient is used here and throughout the paper in the sense of production efficiency, a given output is produced at the lowest cost. In this case a target level of pollution control is achieved at the lowest possible cost. Its use here should be

the desired level of effluent reduction at the lowest cost. The mechanism by which this is achieved is the equalization of the marginal cost of abatement (MCA) across all pollution sources (Tietenberg, 1992). This is illustrated in Figure 1 which compares a standard requiring uniform emissions reduction against an effluent tax. Under the standard the total cost of emissions control for firms A and B is the sum of areas BDF and EDF. Under the tax the total cost of emissions control is the sum of areas CDE and IDG. Clearly the cost of control is higher under the uniform reduction standard. This will be true any time there is a divergence in the control cost among sources. Two other important differences between the standard and charge are apparent from this diagram. First, under the charge levels of emissions control diverge across sources. Second, under the charge polluters not only pay the cost of control area CDE for firm A and area IDG for firm B, but also a tax to the government, area HCE0 for firm A and area HIG0 for firm B. Both of these results have implications for the perceived fairness of a charge policy which will be discussed below.

At a more macro level effluent charges place a price on the use of the environment for disposing of wastes thereby sending a signal to polluters that generating effluent imposes a cost on society. This signal will in turn affect production and consumption decisions throughout the economy resulting in the more efficient use of resources (von Hayek, 1945).

Economists recognize that the concept of fairness or equity lacks a unique definition. Treating everyone the same, pay as-you-go, soak the rich, help the poor are all widely understood, but often mutually exclusive, concepts of equity. While in theory it is easy to couple instruments which promote efficiency with instruments that promote "fairness", this is harder to achieve in practice. Who will bear the cost and who will reap the benefit are central questions in the design of water quality management policy. They are ultimately the key to the political acceptability of any proposed water quality management program. Thus it is critical in evaluating economic instruments for water quality management to ask not only how they will promote efficient, but also how they will distribute the benefits and costs.

4. The Instruments

Economic approaches to environmental quality management consist of three primary instrument: taxes, subsidies and transferable discharge permits (TDPs). This section describes each of these instruments as well as briefly discussing deposit-return systems as an alternative for controlling diffuse toxic pollutants.

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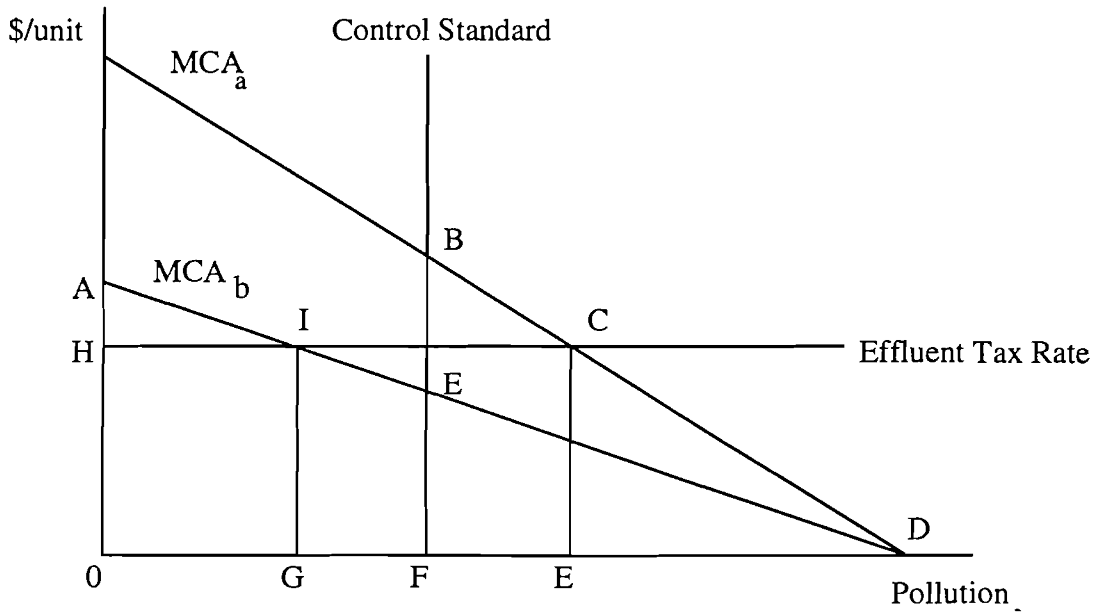
distinguished from it's more general use in economics, allocative efficiency, which implies that certain conditions are met on both supply <u>and</u> demand sides. True allocative efficiency cannot be achieved without knowledge of both the costs and the benefits of pollution abatement.

Figure 1: Comparison of the Efficiency of an Effluent Tax Versus a Standard



4.1 Taxes/Charges

Taxes or charges on pollution producing activities can be imposed in a variety of ways - on the pollutant, on the final product or on inputs into the production process. In all cases the tax will have three main effects. First, the tax will increase the cost of polluting and therefore create an incentive to reduce emissions. The magnitude of this effect will depend upon the level of the tax and the responsiveness of the firm to a change in the cost of production.[3] Second, the tax forces the internalization of the environmental costs caused by pollution and therefore makes the polluter pay for disposing emissions into the environment. Third, taxes raise revenue.

A variation on taxing the pollutant alone is to use taxes to create a price differential between products on the basis of their contribution to pollution. Products that generate more pollution are taxed more heavily, products that generate less are taxed less, perhaps even subsidized. For example the purchase of a toilet could include a tax based upon the amount of water used per flush with low flow toilet eligible for a rebate. The objective of tax differentiation is to create an incentive for "environmentally friendly" behavior.

4.2 Subsidies

Whereas the purpose of taxes is to discourage pollution generating activities, the purpose of subsidies is to encourage pollution reduction. While in theory, polluters can be subsidized on the basis of how much emissions have been reduced, in practice it is politically unpopular to pay someone not to pollute. Subsidies usually come in the form of either grants, soft loans or tax allowances for capital expenditures undertaken to control pollution (Opschoor and Vos, 1989).

4.3 Deposit-Refund Systems

In deposit-refund systems surcharge is placed on a potentially polluting product. When the product or its residual is returned, and the pollution thus avoided, the surcharge is refunded. The most wide-spread deposit-refund schemes are intended to reduce solid waste disposal, litter and energy use (e.g., beverage containers in most western European countries, car hulks in Norway and Sweden). Water quality is at least an indirect concern behind recently implemented programs to reduce soil contamination and possibly groundwater contamination by requiring deposits on car batteries. Such systems might also be practical for other water pollutants emanating from highly dispersed sources such as household chemicals.

4.4 Transferable Discharge Permits (TDPs)

Under a system of transferable discharge permits firms receive permits to discharge emissions up to a certain limit. Firms that manage to reduce their level of

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[3]Economists use the term elasticity to describe the responsiveness of supply or demand to a change in price. Elasticity is defined as: $\%\Delta$Quantity/$\%\Delta$Price.

emissions below this level can sell or trade their unused permits to other firms which can then exceed their initial pollution limit. The aim of a TDP program is to create a market in "pollution rights" which will enable firms to achieve the economic efficiency objective of equating the marginal cost of pollution abatement across all sources thus minimizing the total cost of pollution control (Hahn, 1989).

Transferable discharge permit programs in their most general form allow trading amongst different firms and across a region (watershed) or nation. More limited forms of "trading pollution" have also evolved to attempt to achieve efficient control of emissions at the level of the firm or a sub-region. These are offsets, bubbles, netting and banking.

Offsets. The purpose of an offset policy is to allow new sources or the expansion of old sources in areas which have yet to achieve the targeted level of ambient environmental quality. New sources or the expansion of old sources is permitted by obtaining emission reduction credits (ERCs) from existing sources. ERCs are made available when existing sources have reduced their levels of emissions below those required by law. The primary purpose of an offset policy is to allow economic development in non-attainment areas rather than achieve economic efficiency in pollution control. Currently offsets are included as a component of air quality management under the U.S. Clean Air Act Amendments of 1977 and under the Plant Renewal Clause of the German Technical Guidelines for the Control of Air Quality of 1974 (Tietenberg, 1990; Opschoor and Vos, 1989). Most of the offsets under the Clean Air Act Amendments have been internal transactions (Opschoor and Vos, 1989).

Bubbles. The "bubble" draws its name from the conceptual notion of treating multiple sources as if they were under a bubble from which there is but a single source of pollution. Originally, the Clean Air Act required compliance by each individual source, each and every stack at a refinery, for example, had to be in compliance with emissions standards. Under the bubble policy what matters are total emissions from the bubble, rather than the emissions from individual sources. Bubbles allow the reallocation of emissions among existing point sources under the condition that total emissions do not exceed the sum of the mandated levels for individual sources. Bubbles thus allow firms to minimize the cost of emissions control by reallocating emissions reduction to the lowest cost points of control, i.e., to equate the marginal cost of control across sources. While the Clean Air Act Amendments of 1977 allow multi-plant bubbles, in practice most bubbles cover only a single plant (Opschoor and Vos, 1989).

Netting. Netting allows existing firms to use emissions reduction credits (ERCs) earned by reducing emissions at existing sources to modify or expand other sources within the same plant. Netting allows firms to avoid the requirements of the new source review process. Its primary purpose is to provide regulatory relief rather than promote efficiency (Tietenberg, 1990).

Banking. Banking allows firms to retain credit for emissions control activities that exceed required levels. Banking allows for the discrete or "lumpy" nature of capital investment in pollution control. Banked credits or ERCs can be retained to allow for future expansion or sold under the offset or bubble schemes described previously

(Opschoor and Vos, 1989).

5. Economic Instruments Evaluated: Conceptual Issues and Practical Experience

The preceding section defined the basic principles of economic or incentive-based instruments for environmental quality management. This section presents the major arguments for using economic instruments in water quality management, evaluates the experience with their application, and attempts to define specific lessons from that experience.

5.1 Effluent Charges

The Case for Effluent Charges. The basic arguments for effluent charges were outlined above: they increase the cost of polluting thus creating incentives to reduce effluent discharge, they force the polluter to pay the cost of using the services of the environment to dispose of wastes; and they raise revenue. Along with these attributes, a effluent charge system may have a number of other attractive features (Brown and Johnson, 1984):

(1) Charges create incentives for firms to look for ways to reduce pollution. This may involve input substitution, changes in production processes and changes in the character of their output as well as effluent treatment processes. For example the German chemical firm, BASF, introduced a system of internal liability for effluent within different branches of the firm in response to effluent charges imposed by the federal government. This system resulted in a 20 percent reduction in effluent discharge (Brown and Johnson, 1984).

(2) Charges increase incentives for municipalities to rationalize sewage pricing policy by establishing waste-load based charges on firms which discharge into the municipal sewage treatment system. Faced with effluent charges, municipalities will seek means to pass back these costs to indirect dischargers thus creating the same incentives for direct dischargers outlined above.

(3) Charges stimulate municipalities to improve effluent monitoring. While the incentive to keep better track of effluent follows from a self-interested motivation to reduce cost, a secondary public benefit results from the generation of more complete and precise data with which to manage water quality. Such is the case in Germany (Brown and Johnson, 1984).

(5) Charges make revenues available for financing water quality improvements. To the extent that these funds are made available to dischargers for pollution control and investment in pollution reducing industrial processes, it will mitigate the unpopularity of a charge scheme.

(6) Charges shift the burden of financing the water quality management program from the taxpayer to the polluter. This may not only make water quality management more attractive to the public, it may also make it more attractive to CEE governments seeking to fulfill a variety of obligations with limited resources.

(7) Charges make more revenues available for water quality management and therefore monitoring and enforcement. As a consequence a higher level of compliance may be achieved. However, financing enforcement through effluent charges may generate excessive enthusiasm for enforcing compliance. This may require some mechanism to prevent abuse.

Experience. The following briefly summarizes the most notable examples of the use of effluent charges in water quality management. No attempt has been made to provide a complete description of these programs, but to offer sufficient background as to glean the key lessons from their experience. Brown and Johnson (1984) review the German program, Anderson (1991) the Dutch as well as the Danish programs and Opschoor and Vos (1989) assess the German, French, Italian and Dutch charge systems.

Table 1 highlights the salient features of the French, German and Dutch effluent charge programs. There are notable similarities and some significant differences. Most notably, all combine effluent charges with the use of standards; none rely on effluent charges alone to provide sufficient incentive to achieved the desired water quality objectives. Revenues generated are used in all to both fund the administration of the program and finance public and private investments in pollution abatement. Except in the case of large plants in Holland and France, charges are based upon average or expected loads rather than actual loads. Household charges are based on a flat rate in the two countries in which they are applied, France and Holland. Charges vary by region in both France and Holland reflecting differences in regional pollution control construction programs rather than differences in assimilative capacity.

Each program also has distinctive features. The distinguishing feature of the German program is the schedule of charge reductions associated with the degree of compliance. No charge reduction is earned for simply meeting the minimum standard, however firms which reduce discharges beyond this standard can receive charge reductions up to 100%.

A striking feature of the Dutch system is that charges can apply to the water boards themselves when discharging into the waters of the state, i.e. large rivers, channels and reservoirs. The state may impose charges upon a water board if the waters under the board's authority are of unacceptable quality. An adjacent water board receiving unacceptable water may also request that the offending water board is charged.

The French program points to both strengths and weaknesses of self-financing local or regional authorities. On the one hand the direct recycling of charges back into pollution abatement efforts has lessened industry's opposition to water quality management. On the other it is recognized that, at some point, industry may effectively block higher water quality standards by refusing to pay higher charges.

Table 1. Cross-National Comparison of Effluent Charge Programs

Country	Pollutants	Administration	Notes
France	- Suspended Matter - Oxidizable Matter - Soluble Salts - Inhibitory Matter - Organic/Ammonia Nitrogen - Total Phosphorus	- Six river basin authorities which are financially independent - Charges levied on firms and households - Revenues raised fund administration and public and private abatement activities - Charges not related to abatement costs - Charges vary by authority - Combined standard/charge system	- Revenues recycled directly back for abatement activities. - Low incentive effect due to low charge rates - Overall impact on improving water quality unclear
Germany	- Settling Substances - Oxidizing Substances - Mercury - Cadmium - Toxicity to Fish	- State (Lander) based - Charges levied on direct dischargers only - Revenues fund administration and public and private abatement activates - Administration costs are high - Charges set by federal government - Combined standard/charge system	- Charges based on compliance levels with discounts for exceeding standards - Exemptions possible for hardship - Notable improvement in water quality - Has possibly promoted technological innovation
Holland	- Biodegradable Matter - Suspendable Solids - Toxic Substances - Heavy Metals	- Administered jointly by the national government and 140 local water boards - Variable rates based on loads - Charge levied on firms and households - Administration costs low - Charges set by water boards - Charges apply to local water boards as well as households and firms - Combined standard/charge system	- Primary intent is financial, but appears to have incentive effect as well - 80% decrease in pollutant load - Aggressive water quality program has not impeded industrial growth - Program may have promoted over expansion of treatment capacity

Sources: Anderson (1991), Brown and Johnson (1984), Opshoor and Vos (1989).

Work by Pethig (1989) is especially relevant given the models of the French and German effluent charge systems whose principal purpose is to finance the activities of the water authority. Pethig shows under a general set of theoretical conditions that water quality management will be inefficient when firms using publicly provided wastewater treatment only pay for the costs needed to finance the system. Industrial wastewater abatement activity will be too low and the public treatment facility will operate at an inefficiently high level. Efficiency requires that firms are charged not only for the cost of treatment but also for the "free service" provided by the assimilative capacity of the receiving water body. All existing charge programs implicitly recognize this fact by imposing standards in conjunction with charges.

Lessons. The effluent charge systems now in use bear little resemblance to an optimal system of charges reflecting the strength, content, location and timing of the discharge as well as the flow, temperature and water quality goals for the receiving water body. Moreover, charges are set too low to induce the necessary level of control to achieve the desired level of water quality alone. Nevertheless, experience has shown that they effectively raise revenue for water quality management and have generated some incentive for pollution abatement and innovation in control technology. Their political acceptability can be promoted by recycling revenues back into investments in abatement projects which clearly demonstrate water quality improvements.

5.2 Subsidies

If the purpose of effluent taxes is to raise revenues and discourage pollution generating activities, the purpose of subsidies is to promote environmentally desirable behavior. However environmentally desirable water pollution control might be, the public opposes subsidies to polluters for two reasons - first, they cost money. Second, paying someone to stop doing something bad seems at best unfair, at worst immoral. Furthermore, granting a subsidy for pollution abatement violates the widely-held environmental quality management objective, the polluter-pays-principle (Opschoor and Vos, 1989).

Subsidies are largely borne of political expediency. Both industry and municipalities argue that they need help to meet new requirements created by environmental legislation, i.e. to make the transition from a lower to a higher level of abatement activity. Many governments accept this position and have instituted subsidy programs for capital investment in pollution control but not the cost of operating the plant once built (Opschoor and Vos, 1989).

It is also recognized that certain dischargers will have difficulty complying with environmental standards. Where uniform standards or charges are applied, subsidies are a means of redistributing the costs and facilitating compliance. Evidence from the U.S. experience suggests that the true hardship cases are small in number and that the regulatory "stick" has been more important that the subsidy "carrot" in achieving compliance with the Clean Water Act (Freeman, 1990).

Subsidies have been critical in buying political acceptance for water quality management. Industry is more willing to agree to controlling pollution if the cost of control is subsidized. Opschoor and Vos (1989) conclude in their survey of the use of economic instruments in the OECD countries that subsidies have contributed little to enhancing environmental quality, they may have been necessary for establishing environmental programs in the first place.

Subsidies may hasten investment in pollution control for two reasons. One, because they lower the cost of compliance and two, those eligible for the subsidy may adopt a "get it while you can" attitude if it is uncertain how much money will be available or how long the program will last. Again, limited empirical evidence from both the United States (Freeman, 1990) and Germany (Opschoor and Vos, 1989) suggests compliance deadlines are more important than subsidies in achieving rapid compliance.

Subsidies may be the only means of achieving pollution reduction from those who are not required to do so. In North Carolina agricultural best management practices (BMPs) to reduce nutrient loadings are voluntary. However, reducing nonpoint source loadings may be more cost effective than tertiary treatment. Municipalities in the Tar-Pamlico watershed in North Carolina have joined together in a river basin association to fund a cost sharing program for agricultural BMPs (Swanek, 1994). Since they have no regulatory means to impose BMPs on farmers the cities must buy their cooperation with the program.

Subsidies appear to have achieved little improvement in environmental quality that would not have been achieved by strict enforcement of water quality standards. Subsidies have also contributed to the general level of uncertainty in water quality management. In the U.S. the federal government's cost sharing contribution has varied from 30 to 85 to 55 percent. Congress has in turn funded different levels of support than were initially requested. The subsidy program may have in fact delayed some investment in pollution abatement at a time when municipalities expected the EPA's cost sharing component to rise (Freeman, 1990).

The most frequently cited criticism of the U.S. construction grants program for municipal water treatment is that it has led to excessive capital investment in sewage treatment. Treatment plant are built with excessive capacity and a bias toward expensive capital intensive processes and away from equally effective, but lower capital cost methods of treatment such as sewage lagoons (U. S. Congress, 1985).

While subsidy programs may be necessary in the short-run to gain political support for water quality management and address the needs of true hardship cases, once established they are hard to end. All subsidy programs breed dependency by narrow interests and help finance the growth of their political clout which in turn is used to push for the continuance of the program. Revenues that could be more effectively spent to address new problems are tied to problems or approaches that no longer require support. Opschoor and Vos (1989) report that France and Germany have begun to shift the emphasis of their spending programs away from effluent treatment to implementation of new, cleaner process technologies, a promising sign.

5.3 Effluent Trading

The primary argument for effluent trading systems is cost minimization. Allowing dischargers to trade permits among themselves will, under competitive market conditions, achieve the cost minimizing condition that the marginal cost of pollution control is equated across all firms. In addition to this argument TDPs potentially have a number of other attractive qualities:

(1) Effluent trading systems are, in theory, administratively simple. Once permits have been distributed, interaction occurs among dischargers rather than between individual dischargers and the government. The water authority continues to monitor and enforce water quality standards, but the permit system obviates the need to administer compliance with technological standards for specific dischargers or the system of effluent charges.

(2) TDPs allow for flexibility. Some firms will choose to significantly reduce their effluent discharge and sell permits, others will choose to increase it and buy them. A TDP market allows for the separation of who pays for pollution control from who installs it thus creating greater flexibility in meeting water quality standards.

(3) TDPs allow for the development of leasing markets wherein firms may acquired permits to meet short-run needs. This feature is particularly attractive in transition periods in which a firm would be better off to lease permits than to invest in new pollution control equipment to be used with outdated process technology. Leased TDPs allow firms the flexibility to forestall investment in pollution control until this investment can be coordinated with new investment in the production process itself, potentially at a lower cost than end-of-the-pipe measures (Tietenburg, 1990).

(4) The initial allocation can be used to achieve distributional objectives at no expense to cost effectiveness. TDPs can be auctioned off, given away, given to some and sold to others. From a cost efficiency perspective the method of initial distribution is irrelevant (Coase, 1960). The efficiency of the system is not driven by the initial distribution of the permits but by the trading activity that occurs among dischargers which drives marginal abatement costs to equality.

The method of initial distribution is not, however, inconsequential to polluters (Eheart et al., 1980). TDPs have value which is either retained by the firm if they are given away or transferred to the government if they are sold. The fact that the government creates this value by establishing a market for TDPs allows them the additional policy flexibility to differentially favor municipalities over industry, one industry over another, growing versus decaying sectors, etc..

(5) Correctly administered, TDPs create a secure property right, that is an entitlement to discharge a certain amount of pollutant over a specified period of time. In doing so, they reduce the uncertainty associated with standards and charges both of which can be changed at any time. If under a TDP system the government

decides to achieve higher water quality standards it must purchase and retire a share of the outstanding permits. The reduction in regulatory uncertainty engendered by a TDP systems allows polluters to make more rational long term decisions about pollution control.

(6) TDPs eliminate the need to continuously revise the water quality management program in response to economic growth. Under a static program of either effluent charges or standards, the level of water quality will be negatively related to growth in population and economic activity. A stable level of water quality can be achieved only by increasing the stringency of the standard or the amount of the charge. Such changes raise the level of regulatory uncertainty against which dischargers must make long-term capital investments in pollution control. Because the ultimate level of water quality is established by the number of permits initially allocated there is no need to administratively adjust the system in response to increased economic activity. Reallocation of permits will occur within the TDP market to accommodate new economic activity. The price of permits will increase with demand, however this price will equal the opportunity cost of pollution control rather than the government's attempt to estimate that value with new charges or standards.

(7) TDPs cost the polluter less than effluent charges. This issue was previously discussed above as an equity concern. It may be a greater concern in CEE countries where there is a pressing need for capital investment in production technology as well as pollution control. TDPs allow firms to retain more resources which can be invested in either pollution control or process technology.

Experience. The experience with transferable discharge permits systems is very limited. The only example of a true permit trading system for water quality management exists on Wisconsin's Fox River in the United States. The other programs might more appropriately be called "offset" schemes since they facilitate offsets between different sources; they do not, however, involve an initial distribution and subsequent trades in permits.

Table 2 outlines the principal features of the existing programs. One other program in Colorado at Cherry Creek Reservoir is not included because of its similarity to the program at Dillon Reservoir. The SO_2 program has also been included to highlight some of the differences between air and water quality management.

The table reveals a number of interesting aspects of emissions trading in practice versus optimistic theoretical results. While there has been speculation in the literature about optimal means of controlling multiple pollutants (Lence et al., 1988; Lence, 1991), existing programs target only one pollutant. While the Tar-Pamlico program includes both phosphorus and nitrogen, that program does not involve permit trading. In all cases the target pollutant is the water quality limiting parameter for that particular water body.

The second observation is that trades are almost non-existent. It has been more than a decade since the Fox River and Dillon reservoir programs began. Both have seen

Table 2. Comparison of Effluent Trading Programs

Case Study	Pollutant	# of Trades	Geographic Extent of Market	# of Discharges	Nature of Discharger
Fox River	BOD	One	Fox River 62 km in length	6 Municipalities & 13 Pulp/Paper Plants	Point - Municipalities and Pulp/Paper Mills
Dillon Reservoir	Phosphorus	One - Some internal offsets have occurred, credits from several nonpoint source control projects have been "banked" for future use.	Reservoir 65 sq. km.	5 Towns & Various Real Estate Developments	Point & Nonpoint - Municipalities and Real Estate Developments
Tar-Pamlico River Basin	Nitrogen & Phosphorus	Creation of a Basin Association, Cost Sharing Program for Agricultural BMPs, Minor Capital and Operational Upgrades of Existing Treatment Plants	Tar-Pamlico River Basin - 13,000 sq. km.	12 Municipalities, Numerous Farms, 2 Industrial Plants	Point & Nonpoint - 12 Large and Small Towns, Farms, One Phosphate Mining Operation
SO_2	SO_2	Many - well organized market, permits tradeable on Chicago Board of Trade and through other brokers	21 States in the East and Midwest	110 Largest Power Plants	Point - Coal-fired Power Plants

Sources: Greenberger (1992), Letson (1992), Novotny (1986), Swanek (1994), Wyatt (1994) one trade. If the efficiency of TDP programs results from the reallocation of abatement activity that tradeable permits allow, how can the program effect any cost savings if no trades occur. Novotny (1986) assesses the Fox River program and concludes that there are six reasons why more trading has not occurred: (1) the program as implemented exacerbates rather than elevates transactions cost for both traders and the State; (2) the market is thin, so the transactions cost for traders trying to find each other is high; (3) trades cannot be made *solely* to reduce costs (emphasis added); (4) trades must be made for a least one year, but not more than five years (the life of the permit). It is not clear to anyone if the State will allow those who have accumulated permits to extend them after five years, therefore increasing uncertainty about the value of the permit in the long-run. (5) The program was established on top of existing standards and dischargers were still required to comply with these standards thus reducing the scope of trading activity. Finally, (6) water quality control costs are less than one percent of product cost for industries involved thus providing little incentive to trade.

John Palmisano, the architect of the SO_2 trading program has observed that the number of trades is not necessarily the best indicator of the cost effectiveness of a trading program (Barr, 1991). Trading may create opportunities within a firm to control effluent at a lower cost simply because the burden of regulatory compliance is less within the new system than in the old. The new policy allows them to exploit new ways of reducing discharges without regulatory review. This may be true for both the Dillon and Tar-Pamlico cases, where activities have been undertaken to offset discharges that have not resulted in actual "trades".

The third observation is that all programs involve relatively homogenous sets of dischargers. This may limit trading activity where there is little opportunity to exploit differences in abatement cost functions. Nevertheless, it makes it easier to identify uniform trading rules and administrative procedures which lower the transactions costs of trading.

Finally, it should be noted that even the much celebrated SO_2 trading program, as practiced, does not successful resolve the problem of the spatial variation of sources. While the EPA has retained the right to approve trades it has permitted trades that, while maintaining the overall level of SO_2 emissions, result in a reduction in air quality over the region it was largely designed to protect - New England and the mid-Atlantic States.

Lessons. A well functioning TDP market requires the control authority to be able to define for each pollutant and each emitter a vector of transfer coefficients which links emissions at location X with concentrations at each pre-defined receptor location. Under this condition specific trades can be identified (Tietenberg, 1993). The TDP market must also be competitive. Examining these conditions reveals the potential shortcomings of TDP systems for water quality management.

In most water quality management problems, in contrast to numerous important air quality management problems (Klaassen, 1994), the pollutant is not well mixed. Spatial variability of the pollutant characterizes the system. Different emitters have differential impacts on distinct receptors. This fact makes it impossible to make trades on the basis of a uniform trading ratio amongst all emitters as each emitter's impact on the receptors is different.

There are three reasons why this is problematic. First, it makes trades complicated. Parties wishing to engage in a trade have no straightforward way to estimate whether or not their trade will comply with ambient water quality standards. The complexity of trades serves as a barrier to trading activity. Second, because trades are complicated and both emitters and the control authority are concerned that trades comply with the standards, the authority must approve each trade (Novotny, 1986). Third, the non-uniformity of emitters impacts on receptors necessitates grouping emitters into submarkets in which their impacts are similar. This reduces the number of players in the market thereby increasing the likelihood that there will be too few actors and too few trades to insure a competitive market.

There are additional issues. If permits are initially distributed free of charge to all existing dischargers, these existing sources are favored at the expense of new sources. If these new sources are firms they will incur the additional expense of acquiring TDPs in the market from other sources (potentially competitors) that initially received their permits for free. At one level it is simply unfair, at another it may discourage investment in new production capacity which has lower operating costs except for the cost of the permits. This problem will be exacerbated to the extent that existing firms have market power. In theory the control authority could withhold permits in the initial allocation to make available to new sources in the future, in practice all existing sources are grandfathered into the system, permits are distributed gratis and none are withheld from the initial distribution (Tietenberg, 1990).

Finally, firms may be unwilling to participate in the TDP market for a variety of reasons. Selling permits may foreclose future options. If the asset value of the TDPs is not large the firm may prefer to retain the flexibility of using its permits later. A municipality may not wish to limit the potential for future growth or face the uncertainty of trying to buy the necessary future permits. Unused TDPs not only represent the right to pollute, but the option to pollute more in the future. Where the current value of the permit is low, dischargers may prefer to hold them.

6. Cross Cutting Themes in Incentive-Based Approaches to Water Quality Management

Not all economic analysis of water quality management has focused on the efficacy of alternative instruments. Other important studies have examined enforcement, the political economy of environmental quality management, capital turnover and the spatial variability problem. This literature is reviewed here.

Magat and Viscusi (1990) performed an empirical study on the regulation of the pulp and paper industry in the U.S. under the Clean Water Act. Their objective was to analyze the relationship between inspections and compliance. They conclude that enforcement of water quality standards in the pulp and paper industry are an "unusual success story." They identify the basis of this success as the coupling of *feasible* standards with *stringent* enforcement (emphasis added) where enforcement is measured as the frequency of inspections. In addition they found that increasing inspections reduced non-reporting of pollutant discharge levels. Their conclusions different from their own previous work on health in safety regulations in which stringent standards are coupled with weak enforcement. That policy does not work.

Enforcement is similarly the focus of Russell's (1990) study of monitoring and enforcement of pollution control laws in Europe. Russell surveys monitoring and enforcement practices in six countries (Belgium, France, German, Italy, Spain and the United Kingdom) and concludes that:

> A general characteristic of the European monitoring and enforcement systems might fairly be drawn as follows: Infrequent, often pre-arranged, visits are made to measure discharges. Defining what constitutes a violation is likely to some large extent to be within the discretion of the inspector who makes the visit. When a violation is discovered, the penalty for it is likely to be fairly small, at least when measured against aggregate corporate profits.

Russell notes that both the probability of inspection and the maximum fine limit are an order of magnitude greater in Germany than in the other countries surveyed but does not present any evidence as to whether this achieves greater compliance. In concluding, he suggests that economists might do well to focus more attention on the problem of motivating compliance rather than attending only to the problem of policy design under the erroneous assumption of perfect compliance.

In an analysis of the distributional impacts of alternative pollution control measures Dewees (1990) asserts that economists have failed to understand the political effects of economic instruments because their work has focused on either the efficiency of alternative instruments or the *diffuse* distributional impacts on the general public, taxpayers, regions, product consumers, etc. (emphasis added). Dewees' analysis focuses upon the impacts of charge and effluent programs on capital (shareholders) and labor (employees,) those interests on which there are large impacts on a small number of people. He finds that shareholders and employees are more negatively impacted by either of the two economic instruments than by standards, and that in fact they may prefer standards to no regulation at all if they are tougher on new firms, thus creating barriers to entry for new competitors. He concludes that charge and effluent trading policies can be made political acceptable to capital and labor if they are compensated for their losses.

In a study with potentially significant implications for transitional economies Maloney and Brady (1988) analyze the impact of environmental quality regulation on capital turnover in the electric power industry. At issue is the policy under the U.S. Clean Air Act requiring new sources to meet more stringent standards than existing sources. They find that this policy creates significant incentives to continue operation of (dirty) existing plants with a concomitant decrease in environmental quality. Ironically those states with the most stringent new source performance standards had SO_2 emissions rates which were 27% higher as a result of delayed investment in new plant and equipment induced by the tougher standards. Their work suggests that policies which differentiate between new and old sources by requiring new sources to meet tougher standards will delay desired environmental quality improvements.

One of the most significant problems of applying either charges or TDPs for water quality management is separating out the impacts of dischargers on receptors. The problem of applying economic instruments in water quality management can be greatly simplified if the impacts of different dischargers do not overlap receptors, or dischargers can be grouped according to their impacts on specific receptors. Eheart (1990) and Eheart et al. (1990) provide two useful techniques for addressing these problems. Eheart (1990) describes a simplified technique for identifying when the impacts of nonconservative pollutants from one discharger can be considered independently of other dischargers. Eheart et al. (1990) present a method for defining groups of dischargers whose impact on water quality is relatively homogenous. While previous studies have used groupings of dischargers to examine the impacts of group differentiated charge or permit trading schemes (Brill et al., 1984; Kshirsagar and Eheart, 1982), these studies identified groupings on an ad hoc basis. Where grouping is possible the task of administrating either permit trading or differentiated effluent charges will be greatly simplified.

7. The Evolving Institutional Context

Instruments are but one part of water quality management. Just as the experience of the last two decades has demonstrated shortcomings in policy tools, so has this experience shown that the institutions that develop and use these tools fall short of their mission. Environmental policy has been criticized as being arbitrary, centralized, narrowly focused and sometimes ineffectual. In response to these criticisms the institutions are evolving to meet the challenge of more effectively managing environmental quality.

In what follows, several of the most recent trends in U.S. environmental policy are briefly described. They are negotiated rule making, ecosystem or watershed approaches to water quality management, decentralization and national expert programs. The bias towards the American experience comes with the apologies of the author.

Negotiated Rule Making. Negotiated rule making has evolved as a response to the criticism that environmental regulations are too arbitrary and the process in which regulations are developed is too adversarial. Ordinarily, environmental legislation as enacted by Congress sets only very broad environmental objectives, such as the "fishable, swimmable" standard of the Clean Water Act. It is the responsibility of the U.S. Environmental Protection Agency (EPA) to promulgate specific regulations through which these objectives will be achieved. In doing this, the EPA develops draft regulations, publishes them for public comment then incorporates these comments as it sees fit into its final regulations. Public participation in this process, whether from industry, environmental groups or state enforcement agencies, comes as criticism of the draft regulations. The alternatives open to anyone who is unhappy with the regulation are to either apply political pressure or find grounds to sue EPA over the proposed regulation.

In negotiated rule making the EPA agrees to involve representatives of all interested parties in the process of drafting regulations from the start. The development of regulations on discharges from pulp mills, for example, might involve representatives of the pulp and paper industry, environmental groups, state enforcement agencies as well as the EPA. The motivation is that the regulations developed out of this participatory process will meet industry's desire for cost effectiveness, the environmentalists' desire for improved environmental quality and the enforcing agencies desire for administrative efficiency. Successful examples of negotiated rule making include drafting regulations on underground injection, asbestos in schools and pesticide standards (EPA, 1992). Potential pitfalls of the process include the absence of goodwill on the part of the participants and the fact that the remedies of political pressure and litigation are still open to everyone if the process breaks down.

Policy dialogues are a similar participatory process used to establish consensus on broader policy issues such as reauthorization of Superfund and use of plant genetic resources.

Ecosystem or Watershed Approaches. From a systems analysis perspective ecosystem or watershed approaches are not new, they are simply untried. The fundamental idea is to evaluate each ecosystem or watershed individually, establish water quality objectives for the watershed, then manage for the water quality limiting parameters rather than a set of pre-established criteria. For example, the State of Colorado has a stringent water quality standard for silver. Cities in Colorado are currently developing programs to control silver pollution mainly generated by home and commercial photo processing. However, there is no evidence which shows that silver is a water quality limiting pollutant any where in the State except for high mountain streams contaminated by mine drainage. Sediment loads create a more significant problem but there are no sediment standards. An ecosystem approach would address the sediment problem first before engaging in an expensive program to reduce silver concentrations. Variants of this idea have been articulated in Somlyódy (1993) and Water Environment Federation (1992).

Decentralization. Over the past ten years the EPA has attempted to delegate more responsibility to the state and local level. While responsibility for implementing the EPA's programs has always been with the State's, there have been greater efforts to assign greater financial and decision-making authority to them as well. The Reagan Administration crafted this policy of "New Federalism" for three reasons. First, the Administration's political philosophy was that the federal government was too big and that programs that could be run at the state level should be. Second, the Administration sought to reduce the financial burden on an over-extended federal treasury by charging the states with more fiscal authority and responsibility. Third, the policy was consistent with grassroots sentiment that the federal government was out-of-touch with the people.

While the original rational for the policy was largely philosophical and financial, the devolution of authority to the state and local level coincides with the current trends towards negotiated rule making and ecosystem management. Both negotiated rule making and ecosystem management include involving the affected parties in the process of program design and taking local concerns into account. Although much of this may be positive, it is worth remembering that the federal government became involved in environmental protection because of a combination of, lack of will at the state and local level, lack of technical expertise and fear that some states might use low environmental standards to attract investment and promote economic development. To the extent that these factors are relevant in the CEE countries we would do well to closely consider the balance between local and national control.

National Expert Programs. The EPA has historically organized itself and addressed problems on the basis of media specific programs. There are branches for water, air, hazardous waste, etc.. Essentially these branches carry out the programs mandated by the various major environmental laws, the Clean Water Act, the Clean Air Act, Superfund which are, in general, media specific laws. While this organizational structure is for the most part logical, it has created two problems. First, reducing pollution in one media has at times increased pollution in another, i.e. an air pollution problem is transformed into a water pollution problem. Second, firms generating multiple pollutants find themselves dealing with not one, but many different offices at EPA. This makes the task of complying with environmental regulations more difficult, costly and frustrating.

In response to these problems the EPA has recently created a small number of "National Expert" programs organized by industry. Two examples are programs in mining waste and pulp and paper. The intent of these programs is to create a single office within EPA with which the industry has to deal to both reduce their regulatory burden and to achieve a coordinated approach to emissions reduction across media.

At this point these programs are new and have yet to establish a record to evaluate the efficacy of this approach. One problem noted by the director of the mining waste program is that these programs have been established on top of existing programs thereby creating conflicts amongst offices within EPA over jurisdiction and resources.

8. Conclusions and Research Implications

The European Economics Community (EEC) *Task Force Report on the Environment and the Internal Market* (EEC, Economic Verlag, 1990) recommends five basic principles for environmental policy in the Single Market (as cited in Howe, 1993):

(1) the prevention principle;
(2) the polluter pays principle;
(3) the "subsidiarity" principle, i.e. placing program responsibilities at the lowest (most local) level consistent with effective overall system performance.
(4) the economic efficiency/cost effectiveness principle;
(5) "legal efficiency", i.e. enforceability.

These principles are no less relevant for the CEE, thus providing criteria against which to judge the applicability of economic instruments in CEE countries.

It is clear from the literature that economic or incentive-based instruments are conceptually consistent with all five criteria and potentially the most effective means of achieving (2), making the polluter pay and (4), economic efficiency. It is also clear that: (a) few of the existing programs using economic instruments were designed to achieve an incentive effect on polluter behavior; (b) there are no pure incentive based program for water quality management; and (c) the limited experience with economic instruments has produced little convincing evidence of significant cost savings. Does this imply that economic instruments should be abandoned altogether? No, not yet. First, while economic instruments may have failed to live up to their promise, there is substantial evidence that standard based approaches have been excessively expensive (Tietenburg, 1985). Second, twenty years experience with water quality management has generated important lessons with which more effective approaches can be designed. The task is to use this experience to identify the most effective mix of strategies to meet water quality objectives at minimum cost. This survey suggests the following lessons:

Lesson 1: Make it simple. The successful German effluent charge program began by controlling only five pollutants, a strictly limited set of threshold values and an uncomplicated rate structure. Modifications of the law to increase the number of pollutants (to 10) and revise the charge system came after more than 10 years of operational experience. The program is administratively simple for both regulators and the regulated.

Effluent trading programs for water quality appear to be moving in the same direction. The complexity of trades involving different impact coefficients was one of the impediments to trading in the Fox River case. The Dillon and Cherry Creek Reservoir programs are based upon trades between point and non-point sources at a fixed ratio. While situations in which trades at a fixed ratio are consistent with the dynamics of the receiving water body may be limited, it may be worthwhile to identify where such opportunities exist. Hughes (1991) identifies saline water emissions from coal mines in both Poland and the Czech Republic as one such opportunity.

What the "make it simple" edict suggests for research is that we focus our efforts on identifying the best simple program rather than the program that is simply the best.

Lesson Two: Clean Water Costs Money. Even a cost minimizing approach to improving water quality in the CEE will require substantial capital expenditures. France and Germany generate these funds with effluent charges. In the United States funding comes in part from the federal treasury, in part from combined water and sewerage charges and in part from the authority of municipalities to issue tax-exempt bonds. The design of a successful water quality management program for CEE countries requires that we ask, at the outset, from where will the money come?

The priority for economic development and the existing debt burden in CEE countries make it unlikely that their governments will be willing to commit substantial resources to improving water quality. The money must come from either effluent charges or the capacity for the water quality management program to attract capital from the public or the private sectors.

Effluent charges have already been discussed. Other than charges, what is needed to attract capital investment in water quality improvement? The answer is the creation of municipal or regional water quality authorities with the power to issue debt and guarantee repayment (Smith, 1984). This may not be as unrealistic as it might sound. Water and sewerage service are provided by monopolies to captive markets. Water and sewerage users are highly insensitive to price changes therefore increased prices will result in higher revenues rather than a decline in demand. Thus it is highly likely that investments in water quality improvements financed by charges on water and sewerage customers can and will be paid back. Evidence of the potential for attracting investment in sewage treatment is witnessed by the substantial interest by American investors in financing wastewater treatment in Mexico after the NAFTA agreement.

The research task is to work with national and regional environmental authorities as well as municipalities to identify financing schemes that are consistent with the existing institutional structure and impediments to the flow of capital into water quality improvements.

Lesson Three: The solution will not be pure. The German, French and Dutch effluent charge systems are used in conjunction with standards. The American TDP programs have not replaced previous standards but rather have been applied on top of them. All countries have means for enforcing noncompliance by issuing fines, revoking permits or both. While a sufficiently large charge will, in theory, induce polluters to reduce discharges to the desired level, no one has yet applied a charge that is large enough to obtain this result. TDPs cannot be applied without an enforcement mechanism otherwise there will be no incentive to acquire the necessary permits.

Nor can we assume away the existing institutional framework in the CEE countries. Whether effective or not standards exist, monitoring and enforcement programs are already in place. While it is possible that some countries will be willing accept revolutionary change in water quality management, it is more likely that most countries will retain significant elements of their existing programs.

The research task is then to identify the incremental steps from the existing institutional framework in each country that will result in more cost effective pollution control.

Lesson Four: We're not smarter than they are. It is the presumption of the traditional rule making process in the United States that neither those who will benefit from a proposed regulation nor those who will be harmed by it have much to contribute to the process of developing the regulation itself. The German success with implementing their effluent charge program contradicts this view. In contrast to the implementation of the Clean Water Act in the United States where much interpretation, litigation and political maneuvering occurred after specific regulations had been promulgated, implementation of the German law was easier because effected parties had been involved in the development of the policy from the start (Brown and Johnson, 1984). The analysis of Magat and Viscusi (1990) of standard setting in the pulp and paper industry also supports the use of broad-based participation in policy design.

CEE governments can learn from both the German experience and the emerging trend toward negotiated rule making in the United States. The result will be a water quality policy that is more likely to be political acceptable to administer, economically feasible for industry and consistent with the aspirations of the people for improved water quality.

The research implication is that we must work with both those who will be affected by water quality management policy and those who will administer the policy to understand the current institutional framework, understand the objectives of water quality management *as they see them*, identify the feasible policy options and provide the necessary technical support to help them evaluate alternative policy options.

Lesson Five. There's something out there bigger than us. The transition of the CEE countries towards market economies has unleashed economic forces that extend far beyond individual sectors, regions or markets. Relative prices are changing and have yet to achieve a stable equilibrium. These changes in relative prices will affect both the ways in which goods are produced and consumers' choice of goods themselves. These effects will in turn have an impact on water quality. Such impacts have already been observed where water quality has increased as a result of the decrease in aggregate output in the CEE countries over the last several years.

If market economics fulfills its promise in the CEE countries and per capita GNP rises, what is the implication for water quality? Two forces will be at work. Higher incomes generate higher levels of consumption and their associated residuals. Higher incomes also generate greater demand for environmental quality and the ability to pay for it.

The fundamental and often hard lesson of economics is - there is no free lunch. While relative prices are still in flux it would seem an propitious time to end the free lunch at the expense of water quality. By placing a price on water pollution now, CEE governments have the opportunity to send a powerful signal into the market - that the services of the nation's rivers and lakes are not free, that pollution imposes a cost on society, a cost that must be accounted for. In doing so at this time, before substantial new investment has been made in restructuring the productive base of the economy, firms will make different decisions about industrial processes, the use of inputs and the composition of outputs. They will be forced to take the cost of pollution into account. The result will be a productive base that is fundamentally less polluting. Because the capital investment that is made now will last thirty to fifty years, it is the single most effective action that can be taken.

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