J. ENVIRONMENTAL SYSTEMS, Vol. 14(4), 1984-85

INCENTIVE OPTIONS FOR HAZARDOUS WASTE MANAGEMENT

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ABSTRACT

The use of economic incentive mechanisms as alternative, or additional, means to encourage reduction of landfill disposal of hazardous waste is examined. Specific techniques discussed are pollution taxes, waste reduction subsidies, deposit-refund systems and transferrable generation or disposal rights. The use of any economic program must be decoupled from advocacy of cost-benefit analysis to render such program acceptable. It is necessary to determine the degree to which any further reduction of reliance on land-based disposal of hazardous waste might be necessary given the likely imposition of bans on certain classes of waste. Presupposing the necessity of such additional action, the transferrable permit and deposit-refund systems appear to hold the most promise for application to hazardous waste management strategies.

Management of hazardous wastes in the U. S. has recently been the subject of wide attention. Under legislation [1] and implementing regulations [2], cradle-to-grave manifest systems and detailed design criteria for treatment and disposal facilities have been promulgated.

Best available practice dictates pretreatment, material substitution resource recovery, and volume minimization to as great an extent as possible prior to ultimate disposal of the residuals on land [3]. There is currently a surplus of capacity for advanced treatment of hazardous wastes [4]. In an attempt to limit disposal of highly toxic wastes on land, and, presumably, to shift a greater amount of waste to more elaborate treatment technologies, U. S. EPA has issued an advance notice of proposed rulemaking which may lead to a ban on land disposal of certain types of hazardous wastes [5]. Congressional action

doi: 10.2190/TEVT-LPU3-XW3V-YP7D
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on the reauthorization of RCRA may force EPA to issue formal findings of acceptability for land disposal in many, or all, classes of hazardous waste.

The history of RCRA hazardous waste regulation suggests that they are ineffective at best. Even if certain types of high hazard wastes are banned from land disposal, it may still be necessary or desirable to restrict even further land disposal. The objective of this article is to review several incentive mechanics which might be used to accomplish such objectives in lieu of or as supplements to explicit regulatory prohibitions.

TYPES OF INCENTIVE MECHANISMS

On a broad level, incentive mechanisms may be classed as either optimal (or efficient) or cost effective. All optimal incentives are cost effective, but not *vice versa.* Optimal incentive mechanisms are those which are designed to equate marginal costs of abatement to marginal damages from unabated pollution [6]. These would be identical in concept to direct regulation designed both to minimize compliance costs and to equate these to derived benefits. Cost-effective incentive mechanisms on the other hand, are obtained by setting the target level of abatement, *a priori*, by an external mechanism, not necessarily by cost-benefit analysis, and using an incentive mechanism, rather than direct regulation, to minimize compliance costs [7].

The distinction between optimal and cost-effective mechanisms is important, since there may be tradeoffs between economic efficiency and perceived equity of a policy [8]. Furthermore, it has been suggested that much prior opposition to economic incentive mechanisms for pollution control on the part of Congress has been due to the reliance on cost-benefit analysis for goal setting [9]. It is much less certain that opposition would be extensive to cost-effective incentive approaches. This article will consider only the latter, cost-effective, strategies.

Four incentive programs in pollutant control have received attention in the literature. First is the pollutant tax, in which a polluter is charged per unit amount of pollutant in its waste [8, 10]. A second mechanism would be the subsidization of polluters at a level proportional to the degree of waste reduction from a base level [8, 10]. A third mechanism, termed deposit-refund, would consist of a proportional credit given to polluters for the amount of waste disposed via a desirable technology; these credits could be funded by a raw materials tax [11, 12]. It is important to distinguish the subsidy mechanism, in which a polluter is paid for the level of reduction in an *undesirable* activity, from the deposit-refund mechanism, in which the polluter is paid based upon the level of *desirable* activity. A fourth incentive program, stemming from early work by Coase involves defining the right to pollute as a property right and permitting free market trading and selling of such rights [13].

In any of these incentive programs, as applied to hazardous waste, the level of application may be either at the generator or the disposal facility. Current

evidence indicates that the number of disposal facilities is far less than the number of generators, so implementation of any incentive program would be more easily applied to the latter class [14]. In subsequent discussion, the word "polluters" will be used to describe the producers of residuals (either generator or disposers) upon whom the incentive program is to be enforced.

Similarly, any incentive program might be aimed at reducing only total amounts (volume or mass) of hazardous waste disposed of on land or the hazard potential of such waste. If a hazard rating factor, which would be a function of waste characteristics, method, and location of disposal, was multiplied by the waste amount, an "equivalent amount" could be determined. Hazard ranking approaches have been developed for regulatory use [15] and for priority ranking of Superfund sites [16]. In subsequent discussion, waste amount (metric tons) will be used with the understanding that this could refer either to gross amount or to equivalent amount.

Taxes

Cost-effective or empirically-set pollution taxes have been discussed extensively with reference to water pollution control [8, 17-19]. However, no direct implementation of pollution taxes to effluent wastewater management has occurred.

The major U. S. experience with direct charges or taxes is the use of industrial sewer surcharges for the reduction of loadings to municipal wastewater treatment plants. These charges have been applied at least since the 1930's, and have been successful in reducing pollutant loadings [8, 20].

Under CERCLA, a waste end tax of $2.13/dry ton was effective after September 30, 1983 on all wastes destined to ultimate disposal. Under the proposed reauthorization bills considered by the 98th Congress, waste end fees as high as $100/metric ton have been proposed [21]. There are also state fee and/or waste end tax systems which impose tax rates as high as $80/metric ton [21].

One major question which needs to be addressed for the waste end tax approach to be implemented is the requisite level of tax needed to achieve a given degree of waste disposal reduction. It would be necessary to estimate the next cheapest alternative to land disposal for a large number of industrial groups to determine their likely response to increased taxes. Such highly disaggregated estimates are being made within the US EPA Office of Program and Policy Evaluation [22]. As a first approximation to this issue, recent studies have estimated the total costs of double lined landfilling and solids incineration of hazardous wastes [15]. From these data, the cost differential has been estimated as $28.70-$44.03/metric ton over a design scale of 3,900-22,000 MT/yr. This differential represents from 16.1 to 55.9 percent of the landfill costs. Hence, it may be concluded that the levels of waste end tax which have been implemented

Table 1. Pros and Cons of Taxes

Pro	*Con*
Minimizes Control Costs	Decreases Corporate Funds for R & D
Minimizes Need for Enforcement	Major Administrative Problem
Encourages Cost-Effectiveness	No Precedents
Cost-Benefit Analyses Performed by Each Polluter	Unforseen Economic Dislocations Possible
Capable of Rapid Implementation	Encourages Governmental Control
Revenue Raiser for Social Costs	If Tax is too Low, it Could Be Construed as "License to Pollute"
Tax Continues during Litigation	If Tax is too High, is Tantamount to Fine
Creates Incentives for Process Modifications	Absent Quality Standards, Health Protection Not Assured
	Precludes Use of Incentives
	Can be Distorted into Revenue Collecting Mechanism
	Inflation May Reduce Impact, as may Economic Growth
	No Set Goals
	Would Change Jurisdiction of Congressional Committees

by the various states, and which have been considered for implementation by the 98th Congress, are within the range necessary to equalize the costs of landfill and incineration. This estimate is conservative in the sense that, if a cheaper alternative is available, a lower tax rate will be necessary to effect an industrial response.

It is, in fact, arguable that current levels of state waste end taxes have resulted in some degree of waste reduction. GAO notes that, in all states where such taxes were implemented, the amount of reported end taxes raised were less than initial projections [21]. Although this was attributed to other factors, such as reclassification of waste and poor tax enforcement, it is plausible to believe that some waste minimization did occur [23].

A number of pros and cons of pollution taxes have been enumerated, and these are shown in Tables 1 and 2. In addition, the incorporation of pollution taxes results in inclusion of the House Ways and Means Committee and the

Table 2. Pros and Cons of Taxes [24]

Factor	*Pro*	*Con*
Establishment	Polluter pays principle may be more acceptable. Easier transition. Harder to delay. Implies public's right to clean environment.	Initial levels must be approximately correct to avoid capital misallocations. Will be opposed by those placing effectively infinitely value on the environment. Requires damages to be reversible in iterative approach. Marginally profitable firms will oppose.
Change	Incentives for R & D. Not susceptible to administrative discretion, bargaining, and decay of "agency enthusiasm through its life cycle."	Information for adjustment may be costly. Adjustments limit corporate long-range planning ability. Will need adjustment with inflation and occurrence of new pollution sources. Not effective for crisis management. May be politically hard to increase.
Administration	Causes shift in consumption to goods producing lower damage. Yields revenue. Not biased to a single control method. Not necessary for initial costs to industries to be known. Decentralized. More likely to be viewed as equitable.	May be more difficult to correct initial error than standard. Not effective for monopoly producers. Might cause regulator to become revenue oriented. Geographical differentiation may be more difficult than standards. Generally will not give incentive for joint treatment.
Enforcement	Nearly self-enforcing. Expertise already exists.	Iterative tax is subject to strategic collusion.

Senate Taxation Committee into the process of authorization [25]; this can complicate the process of legislative enactment, as an examination of the history of CERCLA reauthorization by the 98th Congress will show.

If a degree of hazard approach was to be employed which would result in geographically distinct tax rates, there is serious question as to whether such a concept would be constitutionally defensible, since a pollution tax could be construed as an excise tax, and thus must be geographically uniform [26]. Furthermore, it is not possible for Congress to delegate authority to set tax rates to an administrative agency. Since inflation and economic growth would result in a diminishing effectiveness of a constant tax schedule, it might be necessary to continually fine tune the tax schedules to affect a given degree of waste minimization, which would be rather time consuming.

A final problem with the waste end tax approach is the effect on illegal disposal practices and imports. Any waste end tax would increase the financial incentives for illegal disposal and evasion of manifesting. In addition, to the degree that wastes produced from foreign off shore production of waste generating products would not be taxed, there would be an increased financial incentive for importation, and possible loss of some domestic industry. Such losses could be counteracted by use of tarrifs, however this would have ramifications for the overall U. S. trade policy.

Subsidies

For the purpose of this section, a subsidy is defined as a payment to a waste generator or disposer for the reduction in hazardous waste disposed to land (either with or without hazard potential evaluation). This can be contrasted with a refund approach, in which a payment is made on the basis of the current practice alone. In the case of a subsidy, a payment is made on the basis of a difference between a prior and the current practice.

The effect of subsidies on the activities of pre-existing polluters is equivalent, over the short-term, to the effect of taxes [8, 10]. However, over the long term, the effects of the two policies differ, and they also differ in terms of legislative and administrative complexity. The principal advantages and disadvantages of subsidy schemes enumerated by Mitnick are given in Table 3 [24].

One clear disadvantage of subsidies is the necessity for a budgetary line item from some income source to effect the payments. However, administratively, since subsidy rates can be altered without the need for congressional action, they are easier to fine tune.

Over the long term, subsidies raise important equity issues between old and new pollution sources. It is necessary that, in the establishment of a subsidy program, a base date be defined and used as a benchmark from which waste abatement is determined. In order to prevent companies from increasing their discharges prior to implementation, it is necessary that the base date be set prior to implementation, it is necessary that the base date be set prior to the date of initial consideration of the subsidy policy. For companies which did not exist at this time (or which change their manufacturing processes from this time) there is then a problem in establishing their base level of pollution in order to determine the level of payment. If non-pre-existing sources are ineligible for payment, there is an inequity between old and new sources. If new companies are to be eligible, it is necessary to establish an algorithm to calculate a base level of pollution. This may be as difficult as the use of direct regulation. An examination of the agriculture subsidy program suggests that this issue is a ripe one for disagreement.

As with taxes, subsidies would act to encourage illegal disposal, since the level of payment would be based on waste disposal foregone.

Table 3. Pros and Cons of Subsidies [24].

Factor	*Pros*	*Cons*
Establishment	Likely to be only weakly opposed.	Rewards those who have yet to comply. Encourages increase in discharges initially. Subject to pork barrel treatment. On budget item. Obtaining initial level of pollution is costly.
Change	Can provide incentive for continued abatement. Encourages R & D. Not biased to single technology. Likely to be more stable.	Not effective in crises. May be difficult to reduce.
Administration	Spread costs more diffusely than taxes.	Can encourage entry of marginal firms. May be construed as blackmail. Does not discourage consumption of goods leading to pollution. May need complex bureaucracy to administer.
Enforcement	Likely to be lower.	Will usually not be high enough to cover full cost, hence some standards may still be necessary.

Deposit-Refund Systems

In this approach, a raw materials tax is coupled with a refund or credit for waste sent to disposal [11]. By allowing for a greater refund to disposers using more desirable technologies, an incentive for the use of these technologies is incorporated. The current CERCLA feedstock tax may be regarded as precedent for a deposit mechanism in the hazardous waste area, however, to fund an adequate deposit program, a dramatic increase in these taxes would be necessary [27]. Such increases may engender substantial opposition from the affected manufacturing industries, and may act to discriminate in favor of non-U. S. manufacturers of affected materials.

While no specific experience with a deposit-refund approach in the hazardous waste area exists, there is evidence in other areas of pollution control that this is a viable mechanism. There is a well-established deposit refund program on lubricating oil in West Germany, which apparently encourages recycling and reprocessing [12]. There is also evidence, in the use of beverage container deposit-refund systems, that such systems work to reduce domestic solid waste loadings [19, 22].

The major advantages of a deposit-refund system, particularly with reference to a waste end tax lie in the areas of enforcement and measurement. In a

deposit-refund system, it would be the responsibility of the generator or disposer to show that the waste was disposed of in the manner claimed. Hence, there would be a shift in the burden of proof from the regulatory authority (which, under a tax system, would need to demonstrate the falsity of a claimed route of disposal to increase the taxes collected) to the generator or disposer (who would need to demonstrate that the waste was actually disposed as claimed prior to receiving credit) [3, 11].

Furthermore, if some refund was given even for disposal by land (which would be possible so long as the *differential* between the refund paid to land disposers and other disposers was sufficiently high) then there would be an incentive for the reduction in illegal disposal activity [27]. However, the deposit paid to land disposers should not be sufficiently high so as to serve as an incentive for land disposal and hence encourage dilution (in a worst case scenario, for example, if the cost to a generator per ton of disposal in a surface impoundment became less than its cost for disposal of liquid wastewater to a municipal treatment plant, then there would be an incentive for the diversion of its liquid wastewater into the hazardous waste stream).

If the refund payment was to be based strictly on waste quantity, then there would be some incorporation of quality indirectly insofar as the materials tax would serve to provide a disincentive for the use of less environmentally, desirable substances. Moreover, the measurement burden associated with this assessment would be substantially less than that in the case of quality measurement of waste materials [11].

Deposit-refund systems for hazardous waste management would also tend to encourage the development of third party scavengers who would collect wastes from small generators in order to receive credits (if the credit was paid to the disposal facility and passed back to the immediate source). In this sense, it might serve to reduce costs to small generators for proper hazardous waste disposal.

Deposit-refund systems might have a discouraging effect upon waste minimization and on-site treatment and recycling of waste. Since credits would be given for disposal, and would be very difficult to provide to waste minimizers and on-site recyclers since verification would be problematical, there would be a disincentive for waste minimization (by shifting manufacturing processes, or use of purified raw materials) and on-site recycling [27].

Analysis of the deposit-refund system as applied to hazardous waste management suggests easier implementation than in the case of waste taxes. The setting of tax rates to achieve a targeted degree of land disposal reduction would, of necessity, be an iterative process. Similar fine tuning would be needed with a deposit-refund system, however as long as feedstock revenues had been set sufficiently high, the deposit structure could be adjusted administratively [27]. Hence, the deposit-refund system would be easier to fine tune to reach a desired target than a tax system.

Marketable Rights

The concept of pollution rights stems from the analysis of Coase, proposing that the use of a common resource (such as a receiving environment for pollution) be regarded as a tradeable property right [13]. This would permit the marketplace to determine directly the appropriate price for the right to pollute.

There are a number of basic design features to pollution rights. First, they may be constructed as emission rights or as ambient degradation rights –i.e., they may carry the right to discharge a fixed quantity (as modified or not by a hazard index) of pollutant, or they may allow the ambient environmental quality at a given point to be altered by a certain incremental concentration. As in the case of pollutant taxes, the use of ambient rights requires substantially greater information than the use of emission rights.

A second design feature is the means of initial allocation of rights. They may be distributed by auction, or they may be distributed freely according to an allocation formula.

Lyon has considered the initial allocation problem and compared a single price auction (all rights are sold for the lowest accepted bid), an "incentive compatible" auction (a successful bidder winning j rights pays an amount equal to that bid by the next lowest bidders for j rights), and free initial distribution to polluters [28]. The incentive compatible auction was proposed to avoid the problem of collusion among bidders. All three mechanisms, when applied to a particular case study produced lower total costs (abatement plus cost of rights) than uniform regulation. The free initial distribution method appeared most equitable from the view of the sources since it produced the lowest cost paid for rights. Lyon also notes the possible effect of initial manipulation on the free allocation method, for example if the allocation is based on pollution emitted at some forthcoming date, then an incentive is provided for the temporary increase in loadings from sources [28].

If rights are allocated freely, they may be allocated either among sources of pollution or to potential receptors. In the latter case, it would be necessary for waste sources to purchase an appropriate number of pollution rights from receptors for their legal discharge of material. Classical economic arguments have been presented to indicate that the final distribution of pollution rights among the generators will be independent of the initial method of allocation [6]. Note, however, that if rights are allocated to sources initially, then some sources will receive income from the initial trading (by sale of "surplus" rights) and there will be some inequity between old and new sources, while if rights are initially allocated to receptors, then all income from the initial trading flows to impacted areas. In addition, free allocation to sources would likely be opposed by environmentalists since it would confer imply the existence of a free "right to pollute."

Hahn and Noll have recently proposed a compromise initial distribution method, called the "zero revenue auction." [29] In this method, each polluter is asked to submit a schedule of quantity of rights they would purchase at each possible price (i.e., a demand curve). The total demand at each price is calculated and the market selling price determined by the intersection with the predetermined number of rights to be sold. Each firm then pays the selling price times the difference between the number of rights purchased and the provisional allocation (provisional allocation equals the firm's *pro rata* allocation of total rights). If the latter quantity is greater than the former, the firm receives a payment. Both the total paid by all firms and by the government are zero. Clearly, the initial transaction costs of the method are quite high, and would require participation by all firms. While incorrect reporting (deliberate or accidental) can affect the final selling price, the authors assert that "the trades that result will still be mutually beneficial to all firms in the market."

Hahn and Noll's auction procedure, in actuality, is a disguised version of an initial free *pro rata* vesting in sources, insofar as an income effect on sources is concerned. However, the property rights are implicitly inherent in the government, rather than the polluter, since nonparticipation in the auction would result in the failure to acquire any rights. Furthermore, the zero revenue auction assures, at least initially, a fair market in rights and the absence of hoarding.

A third major design feature of pollution rights would be their permanence. They may have perpetual or nonperpetual duration. In the latter case, a certain number of rights may be designed to expire per year so as to lead to a continued reduction of pollutant sources.

A fourth design feature of rights would be their geographic extent. If hazardous waste rights were to consist of the right to dispose of x equivalent tons/year, these rights could be nationwide, or subject to zone restrictions. The zoned rights system would be more capable of considering geographic variation in hazardous waste assimilation capacity of environments, however, it would be more complex to administer and would undoubtedly produce some dislocations at the boundaries of the regions.

Finally, a rights system can be implemented incrementally, unlike taxes or deposit-refund systems. As del Calvo y Gonzalez has discussed with respect to atmospheric emissions, a tradeable permit system (offset approach) can be used in which polluters propose specific trades in generation to the regulatory authority for approval [30]. In this approach, the burden of monitoring is shifted somewhat from the enforcement agency to the polluters proposing such trades.

Pollution rights have been discussed in a variety of contexts, although they have received only limited application. David [31] and Eheart [32] analyzed the application of marketable permits to the control of wastewater phosphorous inputs into Lake Michigan. Mackintosh presented detailed calculations on the application of marketable rights to air pollution control on a regional basis [10].

Table 4. Pros and Cons of Rights Systems [24]

Factor	*Pro*	*Con*
Establishment	Readily derived from conventional permit system.	Opposed as implying tolerance for pollution. Marginal firms will oppose. Initial auction may be unfair to firms with cash-flow problems.
Change	Response to growth is inherent. Even under collusion, the "correct" goal is attained.	Inflexible to emergencies. Can be used as barrier to entry of competing firms.
Administration	Achieves desired goal even when costs are poorly known.	May lead to undesired concentration of polluters. Would not seem to be applicable to toxics. Would not serve as a continuing revenue source.
Enforcement	Problems of enforcement are of a similar nature to those in directive systems.	Problems of enforcement are of a similar nature to those in directive systems.

The offset, bubble and emissions banking programs under the Clean Air Act have permitted testing of the limited transferrable permit concept. Oates notes that banking programs have been approved in Louisville, San Francisco, and Puget Sound [33]. As of the end of 1982, about 1900 offset transactions have taken place. However, in some situations, excess rights are retained as a means of restricting the entry of competing firms [34]. According to Melamed, this problem has lead to consideration of proposals in which rights would expire (or revert back for re-sale) at the end of the useful life of the pollution source [34].

The concept of freely exchangeable pollution rights has precursors in a number of other situations in which free market forces have been used as regulatory tools. Some other areas of application of this type of system are:

- ration systems for commodities in which "white markets" are permissible;
- allocation of taxi medallions in many cities (e.g., New York);
- regulation of mineral or water rights (particularly under the prior appropriation doctrine); and
- allocation of various municipal franchises on a price-competitive basis (cable television, etc.).

The advantages and disadvantages of rights systems as summarized by Mitnick are noted in Table 4 [24].

Oates has compared the use of marketable permits to effluent fees, and notes that the former have a number of advantages over the latter [33]:

- rights are able to achieve a given level of pollutant reduction with less uncertainty;

- economic growth and price inflation have no effect on environmental attainment with rights (prices of rights merely increase), while fees would have to be deliberately increases to keep pace;
- if the initial distribution of rights is made on a free allocation basis, the total cost to polluters is substantially less than under a tax system (in an auction allocation method, the total costs borne by the polluters would be similar);
- geographical variations could be more readily accounted for in a rights system than with taxes; and
- marketable permits are perceived as a less radical change in practice than implementation of pollution taxes.

Russell has also discussed the issue of costs to polluters associated with various initial allocation schemes in a transferrable permit system [35]. If initial allocation were made to polluters, the costs would be less than a tax or an auction system, however such allocation scheme may be perceived as a "giveaway" of the right to pollute. On the other hand, in an auction system the dollar amounts paid by polluters at an auction could be high. Hahn and Noll analyze application of marketable permits to SO_2 control in Los Angeles [24]. Correcting existing inefficiencies in abatement would result in $10 million in savings, however the aggregate value of permits in a freely tradeable program would be $60 million. Oates indicates another study of a transferrable permit system to the regulation of air pollution in which a system of mandatory controls would cost $230 million, a system of fees or of marketable permits would result in abatement costs of $110 million, however $1.4 billion in permit fees or effluent taxes would be paid by polluters [33]. It should be noted that, in most economists' discussions of market incentives, this latter cost (of effluent fees paid or costs of obtaining rights) is often ignored, since, from an overall societal view it represents merely a transfer of social damage costs.

Both Russell [35] and del Calvo y Gonzalez [30] have noted the increased monitoring and administrative burdens associated with a transferrable permit program. Stated simply, it is necessary in both the direct regulation and the marketable permit program to conduct surveillance and to enforce permit conditions. However, in a transferrable permit program, it is also necessary for the regulatory agency to keep track of the exchange of permits between sources.

The fundamental assumption with a tradeable rights scheme is that it will lead to a fair market in pollution rights. Since there have been no direct tests with hazardous waste regulation in this mode (and only limited experience in the air pollution area) this remains untested. Liroff notes a number of problems which might occur in the operation of a pollution rights market [36]:

- With few sellers of rights, hoarding and artificially high prices may occur. This may be due to use of rights as a means of controlling competition (as apparently has been the experience with air trading).

2. If the number of authorized rights is set too high, there may be no market (i.e., the rights may be valueless). In order to provide a continuing incentive for improvement in technology, some minimum price might be desirable.
3. The uniform selling price of pollution rights may be viewed as inequitable *vis a vis* polluters who have taken control steps prior to the policy implementation.
4. Rights might serve as an incentive for premature plant closings (i.e., if they have a resale value on closing, this would encourage early shut-downs).

A number of specific design issues need to be considered in the implementation of a rights program. Among these are the geographic range of permits (whether permits should be nationwide or only within restricted zones), the bankability of rights (whether rights unused in a given year may be carried forward into another year), the initial allocation method, and the use of the income which might accrue to the government from an initial auction. Additionally, the role of a regulatory presence as a broker or banker of rights should be determined.

It should be noted that a program of transferrable rights has the potential to accomplish multiple goals in the control of hazardous waste management practices. A system can be devised which can control disposal opportunities and yet provide incentives to local communities for accepting disposal operations within their boundaries. Such a system might have the following features:

- The right would be for the disposal of a given total equivalent tonnage (based on a hazard ranking) of waste over the site life -- in this sense rights would be bankable.
- Initial allocation would either be to existing hazardous waste disposal facilities, or to communities in which these disposal facilities were located, in either case on a basis proportional to capacity. Rights would be forfeited upon closure of the facility (with zero salvage value to prevent premature closure). Allocation to communities would require facilities to purchase rights from holders and thus indirectly compensate the communities for the presence of a hazardous waste management facility. (It is not necessary, though it may be desirable, that facilities purchase rights from the specific community in which they are located).
- The forfeiture of rights upon closure would free up a pool of new rights for reallocation (some of the rights might be irrevocably retired to promote continued reduction in hazard due to disposal). New facilities would have the option of either purchasing rights directly from pre-existing facilities (and thus forcing the latter to reduce the volumes of waste handled) or from the pool of forfeited rights. The money received from sale of the latter (which, for equity, would be at a price no less than available by private sales) might be distributed as compensation to the community in which the new facility is sited.

COMPARISON OF ALTERNATIVES

At this point, the features of each of the market approaches to regulation may be compared with each other and to the direct regulatory option. Where available, the direct implications in regard to hazardous waste management will be noted.

The consideration of market incentives by economists in comparison with direct regulation has often been an unfair one. Since economic incentives have been subject to very little direct testing, assumptions as to their political uncorruptability are unsupported. Majone observes [37]:

> The comparison between, say, an uncorrupted system of effluent charges and a regulatory mechanism captured by special interests in a specious one. Where effluent charges have been used – for instance, in France – they have proved to be as subject to bargaining and as conditioned by considerations of political and administrative expediency as have standards, licenses and other regulatory measures. Thus, the search for a system that "would resolve most of the political conflict over the environment in a highly visible way," in the same sense in which the planning-programming-budgeting was supposed to lift the budgetary process out of the morass of political compromise, is bound to lead to disappointment . . . .

Hence, it is unrealistic to support that market incentives for the alteration of hazardous waste management practices would be less susceptible to lobbying (either at the congressional or agency level) than direct regulations or bans.

Anderson *et al.* have considered the various realms of environmental protection in which market incentives might be suitable [25]. These authors concluded that direct regulations, rather than incentives, were appropriate when toxic pollutants were under consideration. However, they also noted that, when abatement technology was not well characterized, market incentives were more appropriate. It would appear that the regulation of hazardous waste land disposal practices falls in an intermediate category, i.e., some of the material may be toxic, however the technology available for abatement is not well characterized, and thus there would be applications for both direct regulation and market incentives.

If the paradigm of Anderson *et al.* is accepted, then the fraction of hazardous waste which is most toxic and for which alternative technologies are most well known would be more appropriately subject to direct regulations, while the wastes of lesser toxicity (or more uncertain technology) would be more appropriately managed using market incentives [25].

Regulation, charges, and tradeable permit systems behave differently under uncertainty. There is a tradeoff between the certainty of environmental quality attainment coupled with lack of cost-effectiveness (but perhaps a greater degree of equity) under direct regulation and the uncertainty of environmental quality but certainty of cost-effectiveness using the taxes, subsidies, or deposits and

refunds [37]. Pollution rights perhaps are a compromise, in which attainment of environmental quality is more readily assured, but there may be lesser certainty of cost effectiveness due to market imperfections.

Revesz has more fully analyzed the situation with regard to imperfect data [7]. If it is desired to achieve the optimal regulation (marginal costs equal marginal benefits), then the degree to which a standard may be suboptimal or superoptimal is determined by the quantitative differences between the expected and the true marginal cost and benefit functions. However, using a cost-effective approach (with an *a priori* set environmental target), so long as the expected marginal cost curve is greater than the actual (i.e., control costs are not underestimated), then a marketable permit approach will produce acceptable results while the effluent tax approach will lead to lower levels of pollution than targeted.

The relative costs of administration of the various market incentive programs have not been considered in detail. It has been reported that the Minnesota hazardous waste end tax included a budget of 22 percent of revenue for administrative, collection, and enforcement costs [22]. Putnam, Hayes, and Bartlett noted total FY84 enforcement costs for RCRA and CERCLA of $21.6 million, and estimated administrative costs for waste end taxes of $70 million, and deposit-refund system costs for administration of $490 million [27]. However, as this latter study noted, the anticipated beneficial effects of a deposit-refund system (*vis a vis* reduction in illegal disposal and future remediation costs) more than outweigh the added administrative costs. There do not appear to have been any attempts to analyze the administrative costs which would be incurred in a pollution rights scheme.

A final comparative feature contrasting the various incentive-based approaches is their ability for incremental implementation. In a pollution tax method, since tax rates must be congressionally set, incremental adjustments would be difficult to accomplish. This also would probably be the case with a direct subsidy program, since it would represent a budget item. For a deposit-refund approach, as long as sufficient revenues were available from the materials tax, it would appear to be possible, administratively, to reduce the extent of waste disposal by increasing the differential in credits between land and alternative disposal technologies. In the case of pollution rights, particularly where reversion upon closure occurred, the reduction in disposal could be accomplished merely by the cancellation of unused rights. Furthermore, it would be possible for the regulatory authority to enter the marketplace to purchase additional rights from generators. These transactions are analogous to activities of the Federal Reserve Board *vis a vis* money supply regulation.

LIKELY REACTIONS FROM INTERESTED PARTIES

The reaction of business towards pollution taxes in general has historically been negative. Seneca and Taussig cite three bases for this opposition [38]:

1. regulations, particularly those weakly enforced, are preferred to taxes due to their greater potential for cost avoidance;
2. a system of charges implies a *de facto* change in ownership of the environment from the polluting industries to the public; and
3. they are perceived as unnecessary and redundant once standards and regulations have been implemented.

These observations are in general agreement with the findings of Kelman who, in 1978, interviewed congressional staff and business and environmental interest groups on the subject of economic incentives [39]. All staff of the Senate Subcommittee on the Environment, the House Subcommittee on Water Resources, and personal staff of full committee members who spent significant time on environmental issues were interviewed. In addition, professional staff of Washington-based environmental and trade organizations were interviewed. A total of sixty-three persons were polled. Pollution taxes were opposed by 37 percent of the environmentalists and 85 percent of industrial groups. Republican staff were more receptive to such taxes than Democratic staff. There was an association between the tendency to use the word "criminal" to describe polluting behavior and the reluctance to accept pollution taxes among Democratic staff and environmentalists. Kelman proposed that the opposition to pollution taxes among environmentalists (and Democratic staffers) may result from the perception that economic incentives confer an air of moral acceptance of polluters behavior, while regulatory schemes confer an implication of "bad" behavior [39].

The findings of Kelman must be tempered by the emphasis upon optimal taxing schemes (equating marginal costs and benefits) as opposed to second-best, or cost-effective taxing schemes [7].

As a component of the present study, several parties with a direct interest were contacted for their opinions on market incentives for modifying hazardous waste disposal practice. Care was taken to differentiate the goal from that of revenue raising (associated with the current proposed modification in CERCLA).

Richard Fortuna, Executive Director of the Hazardous Waste Treatment Council, expressed the opinion that direct regulations are the most suitable means of control of waste management practices [40]. He was of the additional opinion that waste end taxes should be used primarily at the state level for revenue generation. Of the options discussed here, he believed that the deposit-refund scheme would have the best opportunity for implementation. However, members of the Hazardous Waste Treatment Council would be reluctant to be seen as needing subsidization for the utilization of their technologies, and hence such refunds or credits would be preferable if given directly to the generator.

Dr. Suellen Pirages, of the Institute for Chemical Waste Management, National Solid Waste Management Association, questioned whether pollution taxes work in changing behavior, and whether any market-based system in the absence of

regulation has ever been effective [41]. In addition, since landfill banning at some level appears to be imminent, the necessity of the additional regulatory burden associated with market incentive mechanisms was questioned.

Dr. Geraldine Cox of the Chemical Manufacturer's Association was contacted for reaction [42]. However, she declined to provide specific comments to the idea of market incentives, and merely noted the low percentage of waste generated by CMA member companies going to landfills, and the relatively low degree of profitability of these companies (hence the potential for adverse financial impact from a pollution tax or rights auction).

Kenneth Kamlet, Director of the Toxics Program of the National Wildlife Federation, felt that economic incentive mechanisms are necessary and desirable in addition to regulatory approaches [43]. He expressed a preference for subsidies over taxes, due to workability, and suggested that marketable permit schemes would not be desirable for conservative pollutants.

CONCLUSIONS AND RECOMMENDATIONS

The use of any economic incentive program must be decoupled from any attempt at cost-benefit analysis, since it is apparent that much opposition to incentive-based programs stems from such coupling [9]. Hence, it is suggested that an initial decision be made as to the extent of reduction in reliance on land disposal which is desired. It would be desirable to also develop a simple hazard scheme by which waste "quality" could be judged.

Economic incentive mechanisms have a clear role in the reduction of reliance on land disposal even given a ban on the land disposal of certain constituents. For wastes of extreme toxicity where alternative management technologies (either disposal or recycle) are few and are very costly, banning would be the most appropriate regulatory vehicle. For lesser toxicity wastes, and where cost differentials are less, economic incentives would be more desirable, as a means of encouraging technological development. Very roughly, one could imagine a first tier of wastes, where outright bans would be appropriate, a second tier of wastes, where economic incentives would be appropriate, and, perhaps, a third tier of wastes which would be deemed relatively acceptable for management at land disposal sites.

Presupposing a ban on land disposal of certain categories of wastes, one basic question which must be answered is whether additional reductions in reliance on land disposal are necessary. From a practical point of view, if the rate of creation of new land disposal capacity was to lag the rate of disposal to land, then a long-run shortfall would be indicated. Accepting the fact that some wastes would always, of necessity, require land disposal (due to unavailability of alternative technologies and ease of pretreatment and containment), it is necessary to decide whether any action (either by command and control or by market incentives) is necessary to ration land disposal capacity. Basically, it

must be determined whether the difference in impacts between a capacity shortfall sooner (in the unrationed case), rather than later (in the rationed case), is sufficient to justify any intervention. The savings which might result by such intervention could be used to justify control of non-banned wastes.

Should it be found that banning of wastes is sufficient to reduce the rate of land disposal below that of capacity creation, then no further intervention would be called for.

Throughout this article, and indeed pervasive in the analysis by all economists, is the assumption that firms will act rationally in response to financial incentives – i.e., that they will modify their behavior to minimize their costs. This may not be true if the firms lack true information. Furthermore, other goals may either add to or diminish from financial incentives for land-disposal minimization. For example, criminal liability to corporate officers may result in more abatement action than would be predicted from financial incentives alone. Alternatively, a company may perceive the likelihood of penalty for false reporting to be sufficiently low so as to cause a lower degree of abatement than desired. Only empirical evidence can answer the question of sufficiency of financial incentive mechanisms as behavior modification tools applied to hazardous waste management. The most directly relevant evidence appears to be the response of industries to sewer surcharges, which, as noted above, has succeeded in reducing loadings on conventional pollutants to sewer systems.

Of the economic incentives considered, the deposit-refund and transferrable rights programs offer the greatest promise. Federal waste end taxes would increase incentives for illegal disposal, would compete with the attempts by the States to raise funds, and would be the least flexible; thus they are not recommended for further consideration. The deposit-refund system is promising, however it presupposes a dramatic increase in the feedstock tax on chemicals, which is likely to receive strong opposition. The transferrable rights program would therefore appear somewhat more preferable to the deposit-refund system. Subsidies do not appear to be practical, since they would require substantial revenue sources, and since their implementation to "new" sources raises serious equity questions.

In the design of a rights system, prior opposition has been raised by environmentalists for vesting initial allocations in polluters. There would likely be substantial opposition to the initial allocation in local governmental bodies (as means of subsidizing local impacts noted above), since this would result in substantial out-of-pocket costs to current hazardous waste generators and disposers. The zero revenue auction approach discussed above is a possible means of compromise between these groups, and further work is needed to ascertain its likely application to hazardous waste management. The use of a rights scheme on an individual state or regional basis should be considered, and, if possible, individual states should be encouraged to reduce the reliance on land disposal of middle tier wastes by this means. This would provide a serious test

of the applicability of pollution rights as a means of control of hazardous waste management. This local testing would be similar to the current incorporation of offsets in local air pollution implementation plans.

Further additional work on the rights scheme is necessary to estimate the administrative costs, as well as likely prices to disposers from permits. Once a degree of hazard concept is accepted (or rejected), a small geographic area can be analyzed in detail. For each of the major hazardous waste generators, it would be necessary to estimate their abatement costs as a function of the extent of abatement. This would then allow an estimate of the price of rights to be made. Such modelling activities appear to have been conducted by the USEPA in regard to taxation schemes. The costs can then be compared with estimates for comparable costs using a command and control approach (i.e., a mandated percent reduction of land disposal in all existing sources). This latter comparison is primarily a cost-effectiveness one, and would thus allow decoupling from cost-benefit analysis, which, as noted, has received substantial congressional opposition, and for which little basis exists in RCRA.

Should one of the economic incentive mechanisms then be shown to be desirable, the possible legal barriers to implementation must be explored. Preliminary communication with the EPA Office of General Counsel indicates that both the transferrable permit and deposit-refund programs would require changes in statute prior to implementation [44].

ACKNOWLEDGMENTS

This work was completed while the author was an Environmental Science and Engineering Fellow of the American Association of the Advancement of Sciences and in residence at the U. S. EPA Office of Solid Waste. Views expressed are soley those of the author, and not necessarily those of either AAAS or U. S. EPA.

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