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Variable Rates for Municipal Solid Waste: Implementation Experience, Economics, and Legislation

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VARIABLE RATES FOR MUNICIPAL SOLID WASTE: IMPLEMENTATION EXPERIENCE, ECONOMICS, AND LEGISLATION

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EXECUTIVE SUMMARY

Most U.S. waste agencies have traditionally provided unlimited refuse removal to all citizens, funding that service either from their general funds or through flat-rate, "all-you-care-to-dump" billing. This type of service provision represents a simple solid waste policy: clean up the garbage.

Yet by the late 1980s, increased landfilling and incineration costs, tight local budgets, and growing environmental concerns began to fundamentally change the mission of many solid waste agencies. Many agencies began to design programs to divert waste from the "disposal stream."

Since waste-management decisions are fundamentally made by the solid waste customer, waste policy, in fact, becomes a matter of influencing customer behavior. *Price signals are an effective way of influencing customer behavior.* Charging refuse rates that vary with the level of waste disposed can bring market-style decision-making to solid-waste management.

Communities that implement these "pay-as-you-throw" variable rates in conjunction with recycling programs have routinely reported between 25 percent and 45 percent reduction in tonnage going to disposal facilities. Moreover, consumer surveys in these communities show that variable rates influence consumer purchasing behavior, giving them an incentive to reduce household garbage by buying less wasteful packaging, composting yardwaste, eliminating "junk mail" deliveries, and so on.

Over 1,000 communities nationwide now having variable rate systems, up from a handful just a few years ago. This increase in use of variable-rate systems has been driven in part by state legislative requirements requiring or encouraging use of such waste collection fees.

Since the popularization of these fees as recently as the late 1980s, fully 20 percent of legislatures in the United States have implemented laws that encourage or mandate variable rates. Features of successful legislation include: 1) allowing community flexibility, while emphasizing the importance of appropriate and real incentives to customers; 2) making incentives available for implementation of variable rates; and 3) encouraging feasibility studies of variable rates at the community or regional level.

Initial evidence indicates that variable rates can result in reduced waste generation and disposal. However, simply stating program participation figures or providing a gross comparison of tonnage diverted are inadequate measures of the long-term cost-effectiveness of these pricing systems. Program evaluation must take into account local prices, conditions, and facilities, customer behavior, recycling markets, and collection and disposal systems to determine the appropriate emphasis on waste reduction, recycling, and other waste management programs. This is the next key step in improving waste-management decision-making.

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I. INTRODUCTION

Most waste agencies throughout North America have traditionally provided unlimited refuse removal service to all citizens and have funded that service either from their general funds or through flat-rate, "all-you-care-to-dump" billing. This type of service provision represents a fairly simple solid waste policy: clean up the garbage.

In the 1980s and 1990s, tight municipal budgets and heightened concern about the environment have complicated the solid waste task. Now, solid waste agencies are asked to keep their cities sanitary, with only minimal environmental impacts, and at the lowest possible cost to ratepayers.

The greatest catalyst for change in the waste industry has been the national disposal problem. Tougher environmental regulations and exhaustion of existing landfill space have led to a boom in landfilling costs. In some areas, landfilling costs have exceeded $100 per ton (with a national average of around $35 per ton in 1993).[1] Landfill costs may rise even higher as existing disposal resources are exhausted, new landfills do not fully replace existing capacity, and transport across state lines becomes increasingly difficult for political reasons.

Increasing landfilling and incineration costs, tight local budgets, and growing environmental concerns have fundamentally changed the mission of many solid waste agencies. These agencies are charged with cleaning up the garbage at the lowest possible cost. Faced with rising disposal costs, many have responded with a variety of programs designed to divert waste from the "disposal stream," or the stream of refuse headed toward landfilling or incineration. Reflecting widely adopted waste-management hierarchies, diversion strategies include waste-reduction education, composting, and recycling programs.

This array of solid waste options has created the need for some way to decide how much waste should be handled through each strategy. Since most waste-management decisions are made by the person doing the disposing—the solid waste customer—allocating waste to various strategies is, in fact, a matter of influencing customer behavior.

Deciding how to allocate resources among the complex web of available strategies is difficult. For example, it would be ideal—from the perspective of local waste management agencies—to convince customers to purchase extremely carefully, and then reuse *all* their waste materials at home. However, such a solution is probably impossible, and, considering the intensity that such a public relations campaign would require, is certainly not the cheapest way for an agency to fulfill the public health function of a waste agency. Likewise, extremely intense recycling is not necessarily appropriate. Recycling is not a goal in itself, but is one means toward the lowest cost waste-management system possible.[2] Encouraging additional recycling when recycling one more ton of material is more expensive than disposing of that same ton (assuming all appropriate costs are accounted for properly) makes no sense from an economic standpoint, and, when the full

impacts of the recycling process are taken into consideration, probably makes no sense from an environmental standpoint either.

Proper resource allocation involves adjusting use of waste strategies until no savings are available by transferring waste from one strategy or another—that is, maximizing the efficiency for the next unit of waste of each waste strategy.

Planning efforts developed in the electric energy field provide a model for an integrated waste planning approach. In the energy field before the 1970s, an engineering approach was taken in planning for resources. It was assumed that, no matter how many customers wished to "plug in," it was the utility's job to serve all that demand at whatever time demanded. As the cost (both environmental and out-of-pocket) of building new generating resources began to soar, and as siting difficulties increased (particularly for new nuclear resources), electric utilities and regulators began to examine a new approach—"demand-side management (DSM)." The regulators examined the appropriateness and cost effectiveness of conservation in the resource mix. Methods to conduct elaborate comparisons of both demand-side (programs and prices) and supply-side (new generating plants) resources were developed, and utilities and regulators began to examine utilities' "least cost" approach to providing power. Significant efforts in conservation were found to be more cost-effective than serving customer needs through new generating resources at utilities across the country.

These lessons and tools from energy are finding application in the solid waste management industry through changes in pricing policies toward variable-rate pricing systems (similar in concept to increasing block-rate pricing for electric and water utilities). This paper discusses issues related to planning, implementing, and evaluating waste-management options, with emphasis on variable rates. The paper also applies some newer and integrated approaches for solid-waste management.

II. VARIABLE-RATE OPTIONS: SYSTEM PROS AND CONS

Several major types of variable-rate systems have been implemented in communities. These include:

- **Variable Can System.** Customers are billed on the number and/or size of cans subscribed (or less commonly, set out).

- **Prepaid Bag System.** Customers purchase special garbage bags with logos. The price of the bag includes some or all of the cost of collection and disposal of the waste.

- **Prepaid Tag or Sticker.** Customers purchase tags or stickers that are affixed to the waste set out for collection and disposal. Again, the price of the tag/sticker includes some or all of the cost of collection and disposal for a maximum amount of waste.

- **"Hybrid"** A "base level" of can or bag/tag service is funded through taxes or fixed fees, with increments to that service paid through a variable-rate system. The increments are usually paid through bag or tag/sticker systems. These are designated "hybrid" systems because they are a combination, or "hybrid," of traditional tax or flat-rate financing along with an incentive-based bag/tag/sticker systems.

- **Weight-based System.** Weight-based systems charge households for each pound of waste disposed. These systems are being experimented with in the United States as well as overseas. Weight-based systems provide incentives for finer levels of waste reduction, and reduce the incentives for stomping waste. However, the equipment is not yet widely demonstrated (mostly pilot study level projects), and the system is awaiting full certification by weights and measures.

Adoption of these systems has occurred in communities with very different characteristics, including communities of different sizes; communities with municipal, private, franchise, or contract collection; in urban, suburban, and unincorporated areas; with and without recycling programs; and in areas with a myriad of other characteristics.

These communities have learned a key lesson: that one of the particular virtues of variable-rate systems is that they are very *flexible*. They can be designed to reflect local conditions. "Cookie cutter" systems, or adopting a neighboring community's system *in toto*, is very uncommon. Rather, local variations on these basic-theme systems are being implemented to take advantage of local conditions and are designed to avoid local barriers or difficulties.

Table 1

PROS AND CONS OF ALTERNATIVES

System Option	Advantages	Disadvantages	Communities using this option
Variable Can System	If residents already own trash cans of roughly uniform volume, requiring new cans may not be necessary to ensure equitable service. Unlike bags and stickers, trash cans may be reused. Trash cans will not tear. Revenues are fairly stable because fixed costs can be put on smallest service level, reducing revenue risk. Can systems have been used in larger jurisdictions than bag or sticker systems, and are easy to label with address to identify generating household.	Service levels tend to be measured in fairly large increments, so customers must recycle a whole can to save money. If several can sizes are provided, inventory and delivery costs are high. Fewer households can be serviced than with bag collection. Billing systems can be cumbersome and expensive to set up and operate. No recycling incentive below smallest can size.	Hennepin County, MN Seattle, WA Anaheim, CA King County, WA (unincorporated areas) Marion County, OR Glendale, CA Oakland, CA
Pure Bag System	Smaller set-out increments are more easily made available with bags than with cans, improving the recycling incentive. Bag size may be regulated to ensure equitable service for all customers. Prepaid reduces problems of unpaid bills. Bag strength can be specified to reduce scatter. Easy for customers to understand. Relatively low cost to implement—no billing system needed.	An ordering, inventory, and distribution system to maintain must be set up. Revenue uncertainties, because of forecasting difficulties and uncertain fixed cost recovery. Animals may tear bags and scatter trash, resulting in increased litter patrols and customer complaints. Bags can be more expensive to produce and distribute than stickers or customer-provided cans. There is a perception that plastic bags create an additional refuse problem when entering the landfill. Customers must store and otherwise manage bags.	Grand Rapids, MI Reading, PA

Table 1

PROS AND CONS OF ALTERNATIVES

System Option	Advantages	Disadvantages	Communities using this option
Pure Bag System (continued)	Easy, efficient, and clean collection system—faster than can collection and nothing remains on the curb. Size limit easily assured for collectors.	May be difficult to identify who set out bags in cul-de sacs or dense neighborhoods. Recycling incentive truncated at smallest bag size.	
Tag or Sticker	Various types of stickers may be used to identify smaller incremental set outs and improve waste-reduction and recycling incentives. Can be prepaid, thus minimizing unpaid bills. Costs for mailing, storage, and production are minimal. Low cost to implement-no billing system.	Enforcement of size limits is more complicated and will take extra time at curbs by collectors. Revenue uncertainty—recovery of fixed costs not assured. Tag adhesives need to be designed to stick in cold weather. Since stickers are usually placed on bags anyway, it may be simpler to just use bags. Tags may need to be sold at counters, requiring extra clerk time. Bag quality not assured may lead to more scatter and other problems. Not always easy for collectors to see tags when compared to bags or other pre-paid indicators. May be difficult to identify who set out bags in cul de sacs or dense neighborhoods. Customers must obtain, store, and use stickers. May be more complex to understand size limits. Recycling incentive truncated at smallest container size. Stickers left on set-outs at curbside may be susceptible to removal.	Tompkins County, NY Aurora, IL Grand Rapids, MI

Table 1

PROS AND CONS OF ALTERNATIVES

System Option	Advantages	Disadvantages	Communities using this option
Hybrid	Offers communities a way to transition from the traditional financing system to a variable rates option. Mitigates revenue risk by recovering some costs through traditional financing method. Allows customers a method by which they can eliminate the need for any additional "out-of-pocket" payments for solid waste. Allows time for customers and officials to develop system familiarity, and allows time for ramp up of programs. Doesn't "lock in" a community to a specific type of system. Can be implemented quickly, inexpensively, and easily, and can be later replaced or modified into a full variable can, bag, or tag system, under a hand dump, semi-automated, or fully automated system. Allows time for further planning. Allows time for data collection. No new billing system needed.	Customer incentives to reduce waste are truncated at the lowest service level. Full costs may not be explicitly reflected to customers.	Victoria, B.C. Nanaimo, BC
Weight-based	Measures more precise increments of waste generation than do volume-based systems. Better recycling incentive. Encourages waste reduction at all waste-generation levels. Fair and easily understood. Favorable customer survey reaction.	At present, weight-based systems exist only in pilot program form in the U.S. Need more complicated billing system. Special trucks, labeling of cans require extra expense. Weights and measures not yet approved.	Victoria, B.C. (pilot) Seattle, WA (pilot) Farmington, MN (pilot)

Variable can, and pure bag, tag, or sticker systems have been widely adopted. These systems have been selected with some apparent regional preferences—variable cans along the West Coast; bag systems in the Midwest, Mid-Atlantic and Northeast; and tag systems in the Midwest. Some size patterns have also been apparent—smaller communities opting for tag or bag systems, with larger communities tending to select variable can systems. The implementation of variable can systems seems particularly associated with large communities that have or are adopting more automated forms of collection, or that have access to billing systems.

However, most of the communities adopting variable-rate systems have been smaller or medium-sized jurisdictions. Larger communities and highly urban communities have not been among the early adopters for variable-rate systems, with a few exceptions. The difficulty of changing systems (and the politics associated) in a large community, the relative shortages of case-study models for these communities, and a number of perceived barriers (for example, worries surrounding illegal dumping or higher concentrations of multifamily dwellings) have delayed until recently consideration of these options by larger communities.

A. Diversity of Program Features

Along with the proliferation of systems comes creativity in system design, leading to myriad variations to meet local conditions. Our review of the diversity of community systems shows:

- **Collection System Arrangement.** Variable rates have been implemented in communities with each of the four major types of collection arrangements: *private, contract, and franchise* hauling systems, as well as *municipal* collection.

- **Community Density.** Programs are operating in *urban, suburban,* and *small town* areas, as well as systems operating in *rural areas, and counties/unincorporated areas.*

- **Charges for Auxiliary Programs.** Some communities have implemented systems that charge variable rates for garbage, with recycling and/or yardwaste service for no additional charge. Other communities have implemented separate per bag fees for recycling and/or yardwaste, or use *subscription* fees for these programs.

- **Illegal Dumping.** Some communities have adopted very aggressive, proactive policies regarding enforcement and illegal dumping prevention, while others have managed successful programs with only moderate public-information efforts.

- **Low-income Mitigation.** A limited number of communities have elected to offer discounted rates for lower-income residents. Difficulties related to certification and administration have deterred communities from offering this option. At least one community reduced this burden by arranging to have free bags distributed along with welfare checks.

- **Multifamily.** Implementation of variable rates in multifamily buildings remains a difficult problem. A review of the communities shows that this issue has not yet found a widely applicable solution for large multifamily buildings. Some communities view dumpster (detachable container) rates as offering at least a limited degree of variable-rate incentive to multifamily buildings because they are charged based on volume. In theory, this is passed along to tenants through rent. Although the variety of variable-rate programs can be applied to small and medium buildings, the big-building problems of incentives, accountability, and anonymity have not yet been sufficiently resolved to allow direct incentives on a tenant-by-tenant basis.

III. IMPLEMENTATION ISSUES

Despite this diversity in system designs, our interviews revealed several lessons that could be useful in implementing any variable rate system:

- **Political support is important.** Political support can be created, but historically, it often pre-exists in the form of opposition to siting of incinerators or landfills, and public outcry.

- **Involve many in the decision-making process.** Communities have found that involving a number of players in the decision-making process can increase acceptance and smooth implementation of the system. Stakeholders that have been included successfully include haulers, politicians, environmental groups, recyclers, and citizens (for example, through solid waste advisory committees).

- **Offer choices.** Introducing a new system that appears to require lower service and higher fees with no options will be a tough sell. It is important to offer program alternatives (recycling, etc.), smaller service levels at reduced prices, and similar options to allow citizens to reduce their rate burden if they reduce the waste they set out for disposal. Availability of legal, well-known alternatives for the waste, including recycling

opportunities (private or community-sponsored), source-reduction education, and the like, are important.

- **Education cannot be stressed enough.** No community states that it wishes it had conducted *less* public education efforts about the program. Helping customers understand the system and options is a crucial success factor.

- **Improving acceptance.** Many communities are considering implementing these options to reduce the pressure on taxes. However, some jurisdictions are removing funding of solid waste from the tax burden but immediately replacing that with other needs with the result of no citizen tax burden relief. At least one of the communities we spoke with mentioned that they felt that acceptance of the program was high because they actually reduced taxes by the amount that solid waste had cost.

- **Allow program flexibility.** Some communities found that allowing flexibility and feedback from affected private haulers provided system-design options that they hadn't thought of and that were appropriate for the area. Flexibility, rather than mandates, may be appropriate.

- **Prepare politicians.** Local politicians will be in for a great deal of "heat" as system problems arise. Many citizens have considered high-quality, reliable garbage collection to be a "right" for a long time. Arming politicians with information on the systems and responses to commonly raised questions will help them support the concept.

- **Plan for success.** One comment we heard frequently was that the system should be designed with success in mind. Few things were more embarrassing (or potentially costly) to waste managers than purchasing thousands of containers that are soon "too large" for the minimum service that customers need. When integrated systems are in place, with appropriate options, incentives, and education, many communities are finding that 60- and 90-gallon (and sometimes even 30-gallon) containers are larger than customers want. The result is that customers are not induced to reduce waste below the smallest service level, the programs are not used as fully as they might be, and customers are disappointed in their rewards. These communities recommend not "hardwiring" the system for too large a minimum container or bag size. Their recommendation is to offer small bag or small can sizes as options and to provide an efficient distribution system for bags/tags.

- **Pilot systems may be helpful.** In some areas, communities are testing variable-rate systems in parts of a community, or in a part of a county prior to full implementation. This allows them to refine system design, work out distribution and implementation bugs, refine educational efforts, and so on. This may be especially helpful in areas where problems are anticipated, where support may not be strong, a priori, or where these systems are uncommon and unfamiliar.

- **Special collections can reduce problems.** Some communities reported that providing periodic (annual, quarterly, etc.) "special" collections of bulky items, or special "neighborhood clean-ups" helped customers work with the system and helped reduce illegal dumping.

- **Consider local conditions.** Communities should be guided by systems in other communities, but they should not implement a "cookie cutter" system from another community. Communities should use information from several other systems and use ingenuity and local conditions to tailor the design of the program.

IV. IMPACTS OF VARIABLE RATES

In reviewing the relative performance of variable-rate systems in the variety of communities, we have found that the following impacts may be expected.

A. Garbage Tonnage Reduction, Recycling, and Yardwaste Impacts

Communities that implement variable rates in conjunction with recycling programs have routinely reported between 25 percent and 45 percent reduction in tonnage going to the disposal facility. Since most variable-rate systems in the United States have been introduced over the last one to four years, data regarding their impact on waste generation rates are limited. Moreover, many jurisdictions that introduced such systems had either no, or poor data, on their waste generation rates prior to implementing their user fee systems. However, several separate surveys of communities with such programs offer preliminary information.

Minnesota. The state of Minnesota examined results in nine cities with unit-pricing.[3] Only two reported any data regarding waste generation rates: Le Center, Minnesota claimed reductions of as much as 60 percent in residential waste tonnage going to disposal facilities, but reported some increase in commercial tonnage. White Bear Lake reported reductions in tonnage of 22 percent in the first year, and an additional 17 percent in the second year after introduction of the fee system.

Perkasie, Penn. Perkasie, Pennsylvania reported reductions in tonnage sent to disposal facilities of 59 percent after introducing a variable-rate (per bag) system in 1988.[4] These reductions enabled Perkasie to reduce curbside refuse collection service from twice to once per week. The reductions are somewhat misleading, according to Perkasie officials, since the town no longer handled some residential waste such as bulky items.

Multi-city Study. In a graduate thesis at Duke University, Daniel Blume examined 14 cities with variable-rate systems.[5] Blume finds on average that waste destined for disposal declined 44 percent. However, waste reductions ranged from 18 percent to 65 percent, and Blume cautions that the data are not altogether reliable. For example, most cities have had no way of tracking whether waste is being hauled elsewhere for disposal.

Massachusetts. The Reason Foundation surveyed eight Massachusetts cities with variable-rate programs.[6] Five reported waste reductions after implementing their variable-rate systems. One city reported no reductions; one had discontinued the system; and one did not know whether residential waste disposal had declined. Only one city, Gloucester, was able to estimate the amount of waste diversion. The city reported that before implementing the program, the town generated 20,000 tons per year of waste; after introducing the variable-rate fees, waste diposed of in the city dropped to 12,000 tons. Local officials noted that some waste may have been diverted to other disposal sites. In addition, poor economic conditions may have contributed to the decline, so total net reduction due to the program was not possible to calculate.

Statistical Analysis. Preliminary statistical analysis[7] shows that recycling and diversion programs divert 8-13 percent more tonnage when variable-rate programs are in place, even after controlling for mandatory programs and curbside convenience. Furthermore, these figures do not count the influence on waste-reduction behavior, which is notoriously difficult to measure.[8]

Consumer Surveys. Some consumer surveys provide some suggestive evidence that variable rates also have an impact on waste-reduction behavior. One survey by Tompkins County, New York's Solid Waste Management Division, undertaken with two Cornell University programs, was sent to a random sample of local residents in September 1990 after implementation of a variable-rate system. Over 76 percent of respondents reported that variable rates caused them to try to reduce the amount of waste they generated by buying products with less packaging. Over 25 percent "identified additional ways of reducing household garbage. Among the more popular were reusing containers, using cloth grocery bags, buying bulk foods, stopping junk mail, sharing magazine and newspaper subscriptions, and giving away unwanted items."[9]

A 1992 survey by researchers at the University of New Hampshire offers additional confirmation that variable-rate pricing has some impact on waste-generation and buying habits. The study examined consumer buying habits in Dover, New Hampshire, both before and after implementation of variable rates.[10]

The authors divide consumers into three categories, assuming that variable rates would have a different impact on the three categories in terms of purchasing behavior. The categories included "true greens," who already spend personal time recycling; "marginal greens," "who will not go out of their way to recycle;" and the "browns," who tend not to acknowledge a need for recycling.

The survey found that willingness to pay extra for recyclable packaging among the "browns" increased, with over 50 percent willing to pay a 1 to 5 percent premium after implementation of the variable-rate system in contrast to under 30 percent prior to the program going into effect. In addition, those reporting an unwillingness to pay extra for recyclables among the "browns" dropped from 50 percent to just over 45 percent. Among the "marginal greens," the effect of variable rates was to increase the amount of the premium they cited a willingness to pay for recyclables.

The authors of the survey also conclude that "whereas the implementation of a curbside recyclable collection program alone will increase recycling participation rates, a volume-based waste disposal system increases participation rates as well as decreases the absolute levels of waste generated."[11]

B. Declines in Garbage Set-Outs

The Village of Hoffman Estates noted a decline from an average 3.1 units set out (1.86 33-gallon equivalents) to 1.3 stickered bags (a 30 percent reduction). Seattle noted a decline from 3.5 33-gallon cans per household to 1.7 cans after the implementation of variable rates, and a further decline to 1.0 can per household after the implementation of more aggressive rates and a curbside recycling and yardwaste program. Haulers note that, rather than reductions to 3 or 4 set-outs as anticipated when planning variable-rate-programs, they routinely find residential customers reducing set-outs to an average of 1 or 1.5 set-outs per household. Note that these results are more dramatic than the tonnage reductions, because they consider a combination of tonnage reduction *and* compaction of the waste.

C. Illegal Dumping

The verdict on illegal dumping is somewhat unclear. Virtually every community we have interviewed reports that illegal dumping should not be considered a barrier to implementing variable rates. In conducting case studies with many communities that have already implemented variable-rate systems, illegal dumping has mostly been characterized either as a temporary problem that they were able to handle, or as not a problem at all. However, some caveats to this finding may be appropriate:

- These communities have, for the most part, been early adopters of variable-rate systems and may have elected to implement the program because they were confident of citizen cooperation (self-selection bias);

- These communities are on the whole much smaller than many cities, and their citizens may exhibit a greater sense of community spirit and accountability than may be found in a more heterogeneous large metropolitan area;

- Because of pride or media attention, these communities may have an incentive to make the transition look as smooth as possible and therefore may tend to minimize any reports of illegal dumping or other problems; and

- Interviews with haulers indicate that illegal dumping in and around commercial/multifamily dumpsters is often a significant problem and is not generally reported to city officials because collection is usually handled by private companies.

Overall, however, reports of problems are scarce, especially those with measured impacts. Seattle's honor system, in place for 8 years, experienced no significant problems with illegal dumping, other than unquantified complaints of dumping at charitable drop-off boxes. The city compensated by offering these charities lower dumping fees. On the other hand, however, Tompkins County, N.Y. was concerned enough about a possible rise in illegal dumping to hire an "illegal dumping sheriff" who processed about 100 violations the first year.

In a survey of public officials in 10 Illinois communities with variable-rate systems, respondents were asked to rank the dumping problem on a scale of 1 to 5, with "1" indicating that the issue was not a problem. Respondents ranked illegal dumping of waste along roadsides at 2.39; they ranked illegal dumping into commercial and government dumpsters at 2.90.[12]

In his 14-city study, Daniel Blume grouped respondents into three categories. Six cities reported no problems with dumping, four reported minor problems, and four reported notable problems. Blume attempted to identify what variables might influence dumping. He concluded that socioeconomic characteristics appeared not to relate to the dumping problem. He noted, however, that location may be a factor, since three of the four communities reporting notable problems were in rural areas. However, he notes that not all rural areas in his sample reported a dumping problem. He found that convenience of alternative disposal mechanisms may be important to minimizing dumping. Those areas with no means for households to discard old appliances, for example, seemed to experience some dumping problem with "white goods."[13]

A Reason Foundation survey of eight Massachusetts communities with variable rates did not reveal any significant problems with dumping.[14] Five of the eight reported no dumping problems; two reported some dumping, but noted it was not a "big" problem. One reported some roadside dumping, but speculated that some of the dumping was actually from the neighboring community that had high disposal fees for waste.

A number of reports from around the nation conclude that there was illegal dumping before variable-rate systems went into place and that there will be illegal dumping after the implementation of variable rates. However, overwhelmingly, cities with experience in variable rates conclude that illegal dumping should not be considered a major barrier to implementing variable rates and that the problem can be handled with planning.

D. Other Consumer Problems

Some reports of backyard burning and waste compaction in cans have surfaced in discussions of variable-rate systems. For example, Perkasie, Pennsylvania reported increases in backyard burning after implementing a variable-rate program. Seattle noted problems with what has been called the "Seattle stomp," in which consumers attempted to maximize the amount of waste they put into an individual can by compacting it. However, neither of these problems appears to be insurmountable.

Concern about the fairness of variable rates has also been raised. However, in its examination of variable-rate systems, Minnesota state officials reported that communities there do perceive such pricing as fair. Likewise, the Cornell University-Tompkins County, New York survey also found the majority of respondents viewing variable rates as fair. Around 63 percent of respondents found the system to be "fair," and another 15 percent found it to be "somewhat fair." Eleven percent considered it unfair; another 8 percent had no opinion.[15] Participants in Seattle's "garbage-by-the-pound" survey found the weight-based rate to be fair, and they appreciated knowing what they were paying for.[16]

Other equity concerns—such as the impact of variable rates on low-income households—can be addressed through tailored program design. For example, "lifeline" rates to low-income families have been offered in some instances, including, for example, Seattle and Tompkins County, New York.

E. Hauler Concerns

Hauler concerns about unit-pricing focus on the issue of revenue streams and their predictability under variable-rate systems. Will they be adequate to cover fixed and variable costs? The issue is an important one, since much is often made of the concept of "avoided costs" in evaluating waste management programs. For waste management programs, fixed costs represent a larger portion of total costs than do variable costs (for example, 85 percent versus 15 percent in some

instances).[17] With residential diversion rates of 4 to 25 percent (typical of many recycling and composting programs), there may be relatively small reductions in residential collection costs.

Concerns about cash-flow predictions can be overcome, particularly through careful rate and program design. Some communities, for example, use a two-tiered pricing system in which one fixed fee is first charged to all households, with marginal or other charges applied to any additional service purchased.

V. STATE LEGISLATIVE INITIATIVES IN VARIABLE RATES

The volume of variable-rate programs in operation in North America has grown from a few handfuls in the late 1980s[18] to over 1,000 communities by early 1993 and in over 800 additional communities by late 1993.[19] Table 2 below demonstrates the distribution of these systems by state. We have been able to verify communities operating in 25 states as well as systems operating in Canada. This distribution is shown in Figure 1.

Table 2

IDENTIFIED VRP PROGRAMS

State	Municipalties	Counties	State	Municipalities	Counties
CA	21		NV	1	1
CO		1	NJ	18	3
CT	2		NY		3
FL	7		NC	2	2
GA	2		OR	250 **	
IL	38		PA	36	
IN		3	SD	1	
ME	13		TX	1	
MA	40		VT	70	
MI	5		VA	1	
MN	14 *	1	WA	243	
MO	3		WI	75	
MT	1		CAN	1	
NV	1	1	TOT.	845	11
Total Est. VRP Programs***			1,036		

* Minnesota's total will increase to 833 municipalities in August, 1993.

** Estimate by P. Spendelow of Oregon DEQ.

*** Derived by counting the number of municipalities found in each of the implementing counties. Estimate does not necessarily include unincorporated county areas. After August 1993, estimated total VRP programs (including Minnesota's) will exceed 1,800.

Based on our interviews, the increased activity for communities to implement variable-rate systems has largely been driven by:

- increasing landfill tip fees or disposal costs;
- regional diversion goals;
- desire to increase effectiveness of recycling or diversion programs;
- demonstrated success from other communities;
- pressure from citizen or political groups; and
- legislative requirements.

This last factor, state legislation that encourages or mandates variable rates, has had a major impact on the adoption of these systems. Figure 2 shows those states with state-level legislation that encourages or mandates variable rates. These systems have generated significant interest at the state level. Since their popularization as recently as the late 1980s, fully 20 percent of legislatures in the United States have implemented laws that encourage or mandate variable rates. Another 10 percent have considered, or expect to consider in the near future, such legislative initiatives (see Table 3).

Comparing the two maps shows that activity at the state legislative level is closely correlated with the numbers of communities within states that have implemented systems.

A. Specific Regulatory Initiatives on Variable Rates

Legislative initiatives have also had significant direct and indirect impacts on the growth in adoption of variable-rate programs across the nation. Indirectly, state-level recycling or waste-diversion goals have led communities to implement variable-rate programs alone or in conjunction with recycling or yardwaste programs. In a more direct manner, however, some states have provided incentives or mandates for variable rates within state regulation to assist statewide solid waste reduction and recycling efforts.

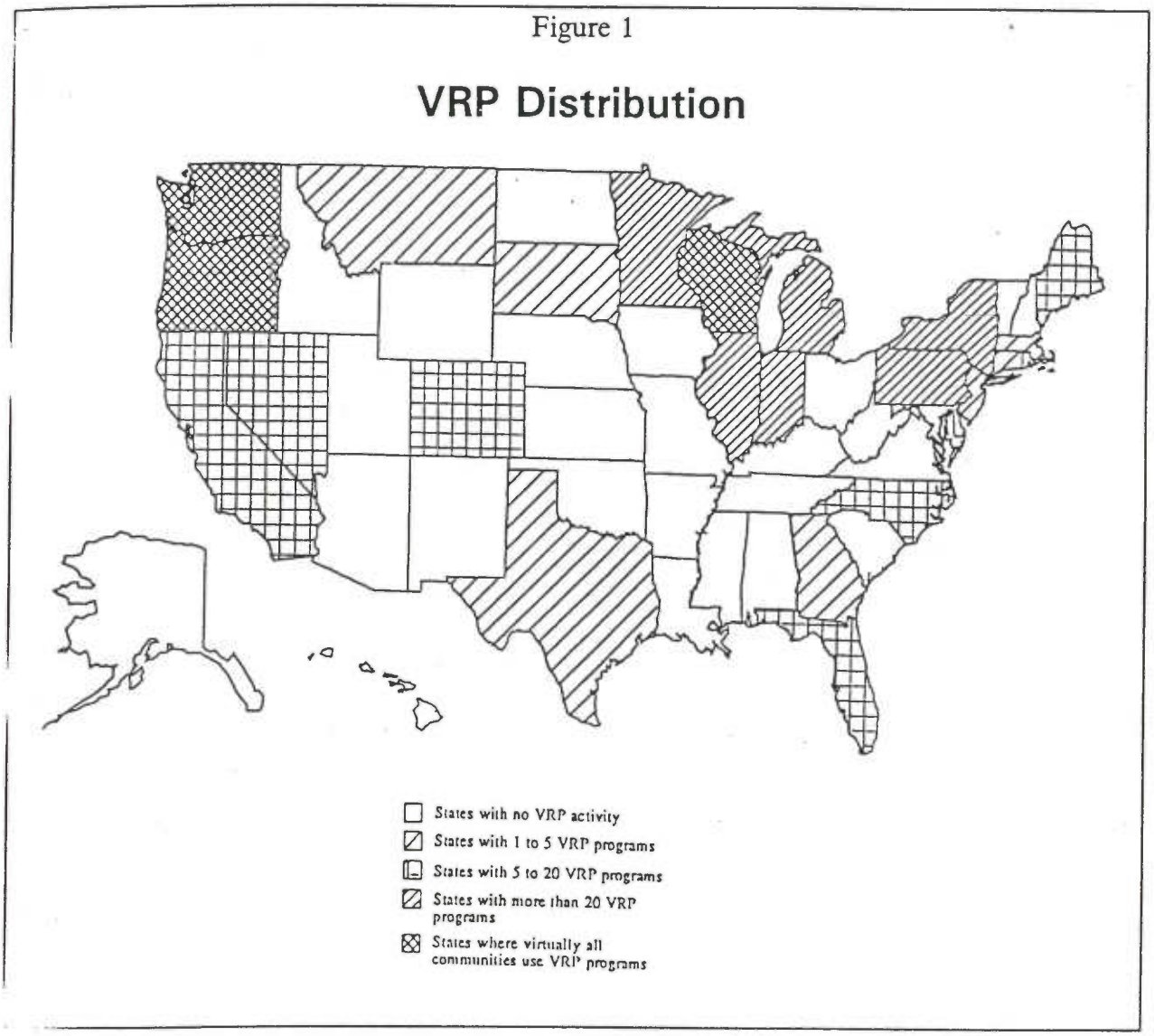
Table 3

CURRENT VRP ACTIVITY

State Activity	Frequency	Percent
Mandate VRP	3 states	6%
Encourage VRP	7 states	14%
Have considered VRP	2 states	4%
May consider VRP	4 states	6%
Have not considered VRP	35 states	70%

As mentioned before, an assessment of the legislative activity at the state level shows that almost 20 percent of the states currently have laws on the books that encourage or mandate variable rates for solid waste. The following section assesses legislative activity at the state level, including:

Figure 1

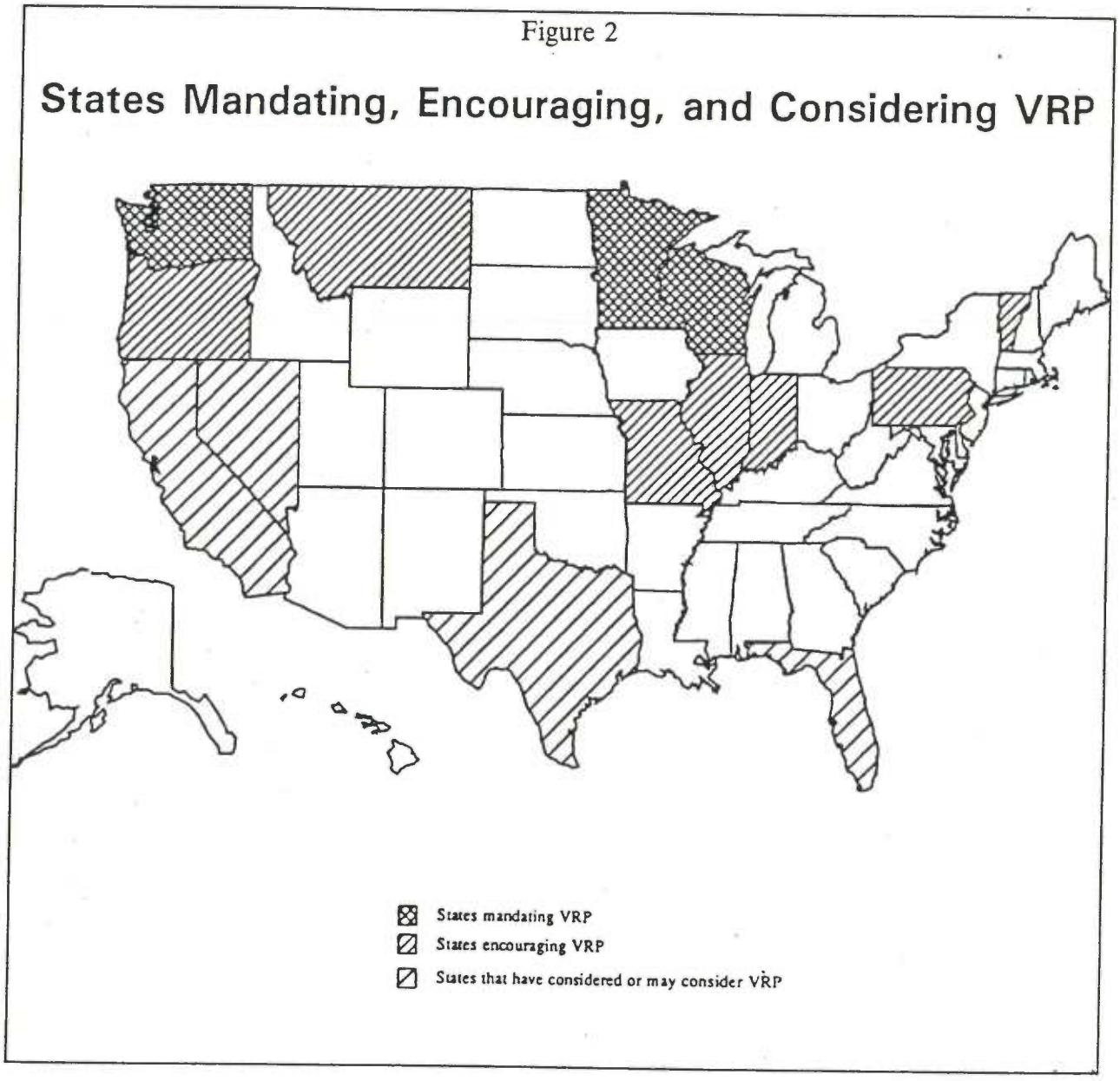


- the extent to which states have mandated VRP;
- the form of existing legislation;
- the state's success in using VRP to reduce solid waste generation;
- why states have not considered using VRP, or, having considered it, decided against incorporating VRP into their solid waste management plans; and
- analysis of legislative alternatives for future variable-rate initiatives.

Survey Results

Based on our evaluation of a survey of legislative activity in each of the 50 states, we have found that experience with VRP at the state level may be divided into five categories:

Figure 2



- states that mandate VRP implementation (3 states);
- states that encourage implementation (7 states);
- states that have considered implementation at the legislative level but have not yet done so (2 states);
- states that may consider implementation in their upcoming legislative sessions (4 states); and
- states that have not yet considered VRP and have no plans to do so (38 states).

1. States that Mandate VRP

Three states—Washington, Minnesota, and Wisconsin—currently have laws that require VRP as part of an overall plan to reduce solid waste.

Washington. The "Waste Not Washington" law (Sec. 20 Section 6), passed in April 1989, requires that certificated recycling and garbage companies that are regulated by the Washington State Utilities and Transportation Commission (WUTC) must set rates that encourage recycling and discourage garbage disposal (i.e., higher fees, rather than lower ones, for a second can of garbage).[20] The WUTC has rate-setting authority over certificated haulers in unincorporated areas of the state, and compliance is mandatory for these haulers (and their customers). Cities that maintain authority over solid waste collection are not covered by this law; however, most communities within Washington state have adopted variable-rate pricing schemes for solid waste collection, and most of the citizens within the state pay for solid waste collection through variable rates. This may be due to the fact that the City of Olympia, Washington was one of the first cities in the nation to adopt a variable-rate pricing system.

Minnesota. Minnesota's legislature has encoded in Sections 115A.93: "Licensing of Solid Waste Collection" (passed in 1989), and 115A.9301: "Solid Waste Collection; Volume- or Weight-Based Pricing" (passed in 1992), the requirement that entities that provide solid waste collection services in the state implement unit-based pricing schemes, consisting of either a volume- or weight-based rate system. The service provider may be a local government that charges directly for solid waste collection or a private company licensed by the municipality to perform collection services.

The Minnesota statutes state that a licensing authority or billing entity:

> *"... shall require licensees to impose charges for collection of mixed municipal solid waste that increase with the volume or weight of the waste collected."*

This regulation went into effect on January 1, 1993.

In addition, licensing authorities or billing entities that implement a volume-based rate system must:

> *"determine a base unit size for an average small quantity generator and establish, or require the licensee to establish, a multiple unit pricing system that ensures that amounts of waste generated in excess of the base unit amounts are priced higher than the base unit price."*

This regulation goes into effect on January 1, 1994.

When solid waste collection costs are presented as a separate and visible billing item, the generator is given constant feedback on the savings impacts of his or her waste-reduction efforts. Therefore, since those who use less service will pay less under VRP, visible billing encourages sustained and/or increased participation in the program. Minnesota has mandated this type of feedback by requiring that:

> *"any political subdivision that provides or pays for the costs of collection or disposal of solid waste shall, through a billing or other system, make the prorated share of those costs for each solid waste generator visible and obvious to the generator" (Section 115A.945: "Visible Solid Waste Management Costs," also passed in 1989).*

To date, anecdotal evidence points to an increase in illegal dumping since implementation of these measures. In addition, there has not yet been statewide compliance with the regulations: of the 59 counties (out of 87 statewide) that license for solid waste management, only 16 currently have legislation mandating VRP. These figures are misleading, however, as counties whose haulers have already implemented VRP have no need to mandate it. Also, no serious opposition to implementation has yet been encountered, and full compliance was expected by the due date.

Wisconsin. Wisconsin Act 335, signed into law on April 27, 1990, instructs communities (a.k.a. "*responsible units for recycling*") to either implement volume-based fees or achieve a 25 percent overall diversion rate by 1995. However, the bill has encountered stiff opposition and may be extensively modified during the next legislative session. VRP is opposed because of:

- the administrative difficulties encountered by municipalities when private haulers must deal directly with generators;
- the linking of VRP to a diversion rate; and
- a general dislike of state interference in local affairs.

2. *States that Encourage VRP*

Indiana, Oregon, Pennsylvania, Missouri, Vermont, Illinois, and Montana all encourage the use of VRP by local authorities.

Indiana. No Indiana state law exists or is pending which mandates VRP. However, Section 13-9.5-9-2(b) (passed as part of House Enrolled Act 1240 in 1990) states that, in addition to other options:

> *"The board* [of a Solid Waste Management District] *may fix the solid waste management fees on the basis of...weight or volume of the refuse received."*

Indiana's Solid Waste Management Districts, which coordinate solid waste management throughout the state, were recently required to submit 20-year solid waste reduction, diversion, and management plans, and among the options discussed at workshops across the state prior to the submittal deadline was VRP implementation. Of the 61 Districts in the state, 55 submitted their plans on time, and the rest are expected by the end of the year. It is not presently known how many of the districts subsequently incorporated VRP into their proposed management plans.

Oregon. Oregon's Senate Bill 66 was unanimously voted into law June 28, 1991 and went into effect July 1, 1992. In S.B. 66, VRP is presented as one of eight "menu" items from which cities, counties, and metropolitan service districts may choose when implementing their "opportunity to recycle" programs, which have as their goal the source separation of recyclable materials. The number of required items and availability of each item varies according to the size of the community.

Specifically, Section 459A.010(h) identifies as one "menu" alternative:

> *"Solid waste residential collection rates that encourage waste reduction, reuse and recycling through reduced rates for smaller containers, including at least one rate for a container that is 21 gallons or less in size. Based on the average weight of solid waste disposed per container for containers of different sizes, the rate on a per pound disposed basis shall not decrease with increasing size of containers, nor shall the rates per container be less with additional containers serviced."*

Thus, VRP is explicitly mentioned as a source-separation incentive at the state level in Oregon. While implementation of VRP is only one of several available options, almost all of Oregon's communities currently employ some form of VRP.

Pennsylvania. Pennsylvania does not mandate but recommends the use of VRP in Act 101, its "Municipal Waste Planning, Recycling and Waste Reduction Act." This act both mandates the establishment of a waste-reduction goal and mandates recycling programs, penalties, and incentives. The Department of Environmental Resources recommends "*variable trash collection fees based on quantity discarded*" as one of five elements in a municipal waste reduction program and promotes the use of VRP through fact sheets and other publications.

Missouri. Similarly, Missouri's Senate Bill 530 (1990) encourages "regional cooperation and planning" in the management of solid wastes, and its Department of Solid Waste Management advocates the use of VRP. However, as is the case with Pennsylvania, VRP is not currently mandated in Missouri, nor is it expected to become law in the near future.

Vermont. The General Policy of the Vermont legislature is that generators should pay the "true cost" of disposal, but no legislation currently exists or is planned that would expressly mandate the use of VRP.

Illinois and Montana. Another way states may encourage VRP is by the imposition of sliding-scale licensing fees on landfills based on total estimated capacity. In this arrangement, larger-capacity landfills pay proportionately more for their license than do smaller landfills. Theoretically, these costs are passed on to generators, encouraging them to reduce waste-generation volumes in order to reduce their disposal costs. Both Illinois and Montana currently use sliding-fee landfill licensing.

Also in Illinois, a bill signed into law in September 1993 requires each Illinois city with a population in excess of 5,000 or county with more than 100,000 residents to complete a feasibility study of volume-based rates. The law does not mandate the use of VRP but does require consideration of its possibilities. The passage of this bill occurred only after the failure of another that would have required implementation of VRP (see below).

3. States that Have Considered or May Consider VRP

California, Illinois, Florida, Massachusetts, Nevada, and Texas are among the states that have considered the idea of VRP or who may do so in the near future. Two of these states: California and Illinois, have tried unsuccessfully to pass VRP legislation.

California. California's Senate Bill No. 1238, as amended on April 15, 1991 in the State Senate would have required the use of VRP, but the bill failed passage in the Governmental Organization Committee. Opposition to its passage was voiced by many local jurisdictions, the California Refuse Removal Council, and prominent waste management firms. The primary reason given for opposition was that billing methods should be considered a local issue and should not be mandated by the state.

On the other hand, Assembly Bill 939, which has been incorporated into the state Codes, requires each city and county in the state to cut its solid waste stream in half by the year 2000. Accordingly, many local jurisdictions have implemented VRP, although they are not specifically required to do so by state law.

Illinois. Illinois also made a recent attempt to pass a VRP law, but this attempt failed for a variety of reasons. The timing of the bill's introduction was one problem, since it was introduced after passage of another bill that required counties to submit solid waste management plans to the state. The prevailing sentiment was that passage of the new bill would put too much of a burden on county resources, since the plans would have to be returned and revised to include this one management alternative.

However, the real opposition to the bill apparently came from smaller Illinois cities, which objected to it on the basis that the bill required cities to perform additional work without providing the financial means to do so. The proposal also fell victim to a rising backlash against what is being perceived as excessive state intervention in local affairs.

Florida, Massachusetts, Texas, and Nevada. The Florida, Massachusetts, Nevada, and Texas state legislatures all may consider VRP during their 1993 sessions.

All other states currently leave the pricing of solid waste collection services strictly to the discretion of local authorities.

4. Reactions to State-Level Initiatives

Different types of legislative mandates seem to have led to different types of VRP activity.

- Activity in states that mandate or encourage VRP: As might be expected, most current activity exists in states that mandate or encourage the use of VRP. This includes virtually all of Washington and Oregon, as well as at least 75 communities in Wisconsin and almost 40 in Pennsylvania. In addition, more than 800 cities in Minnesota will be implementing or using VRP by the August 1993 implementation deadline.

- Activity in states that have been unsuccessful in passing VRP legislation: Even unsuccessful attempts at statewide implementation seem related to high levels of local VRP activity. Both Illinois and California have recently rejected VRP laws at the state level, yet Illinois has almost 40 communities using VRP, and California more than 20.

- Activity resulting from required solid waste management district plans: VRP is also found in states that have no statewide legislation that mandates or encourages VRP but do direct solid waste management planning at the state level. Both Ohio and Indiana are currently reviewing management plans received from their solid waste management (SWM) districts, each of which are made up of one or more individual counties. While the vast majority of SWM district plans have yet to be approved, 3 districts have approved plans that use VRP. In Ohio, district data will not be compiled until July 1993, but some municipalities may have already implemented VRP.

- Activity resulting from countywide solid waste management plans: Another spur to VRP activity is countywide planning. In New York, at least 3 counties require the use of VRP in most or all communities. The same is true in North Carolina and Colorado, as well as unincorporated areas of counties in California, Minnesota, and Nevada.

- Activity not mandated or specifically encouraged by state/county level regulations: Finally, communities in many states have taken it upon

themselves to employ VRP without outside mandates or encouragement. Maine, Michigan, Massachusetts, and Florida all contain many communities that have voluntarily moved towards VRP.

C. Elements of Variable Rate Legislation at the State Level

No single form of the legislation has been adopted universally. The actual language of the laws varies widely, but the legislative initiatives have contained several alternative core elements, including:

- **Feasibility.** Mandating or encouraging communities to study the feasibility of variable-rate alternatives

- **Incentive Rates.** Requiring "responsible entities" to charge rates that increase with higher levels of service with varying degrees of specificity, include:
  - requiring rates that are based on the amount discarded or provide a "true cost signal";
  - requiring rates that encourage recycling and discourage garbage disposal; and
  - requiring rates per pound or per container that can't decrease with increasing service.

- **Small Service Levels.** Requiring small service levels to be made available to customers (at a lower cost)

- **Clear Customer Signal.** Requiring the rates (incentives) to be clearly reflected to the customers (generators)

- **Mandatory vs. Voluntary.** Variations of both mandatory and voluntary approaches have been passed, including:
  - requirements for implementation;
  - allowing the elements as one of a menu of solid waste management alternatives available; and
  - requiring implementation if percentage diversion goals are not met through other methods.

D. Character of Energy Conservation Legislation

The electric industry's experience with demand-side management offers lessons for solid waste management. A wide array of legislative initiatives to encourage energy conservation were debated and implemented at a state and national level throughout the 1970s and 1980s. An

analysis shows that some of the strategies may provide models for parallel approaches for waste-reduction legislation.

- **Prescriptive vs. Performance Approach.** The Northwest's Model Conservation Standards (MCS) provide two options to meet the goals of the program. Buildings may either be designed and built to use only a certain number of kilowatt-hours per square foot energy budget. Alternatively, the building may include a prescribed list of energy-conserving equipment (for example, certain kinds of window glass, restrictions on the percentage of glass in the building, certain levels of insulation, etc.), and that would allow the building to be approved.

- **Measurement Issues.** In order to determine whether buildings met the performance standard, measurement of energy usage was an issue. Certain building energy-simulation computer models were validated and approved that could be used to demonstrate compliance.[21]

- **Enforcement/Incentives.** The "hammer" in the Northwest was the possible imposition of a surcharge on the price for energy purchases from the regional supplier for utilities in the region that served areas that were not implementing the MCS.[22]

- **Other Incentives Issues.** In the Northwest, energy-conservation is also encouraged through the "10 percent cost preference" that is applied to conservation options vs. supplying power through traditional generation. This preference may be interpreted to reflect some of the environmental, supply flexibility, transmission efficiency, or policy preferences for conservation.

- **Implementation.** Direct widespread adoption has been a slow process. In some areas, adoption has occurred at an increasing number of local jurisdictions, and then states have adopted the standards to "even out" the coverage. In other areas, the adoption has been at the state level.

E. Lessons from the Energy Conservation Legislation

Several years of historical experience with these types of energy-conservation standards generally show that:

- options provide essential flexibility—*mandating* one set of options may be less beneficial and flexible than allowing compliance either through meeting goals or through implementing a menu of activities. A legislative

environment that allows flexibility for small vs. large and local conditions is preferable;

- incentives may be useful in speeding implementation; and

- measurement and data are critical in providing ultimate verification of the approaches and validation of the choices. Credibility will never be comparable between engineering approaches and programmatic options if accepted measurement methods are not clarified.

F. Conclusions on Regulatory Initiatives in Variable Rates

Many states and communities are actively seeking to reduce solid waste generation and have considered a varied menu of alternative techniques to meet solid waste reduction goals. This search has resulted in a dramatic growth in the implementation of variable-rate systems in recent years.

- Almost a quarter of state legislatures have already mandated, encouraged, or considered variable rates, and another 6 percent may be considering it in the near future. Given the recent advent of current VRP activity (circa 1988), state legislatures are moving fairly rapidly to incorporate VRP at the statewide level.

- States that encourage VRP while mandating solid waste reduction and recycling seem to be successful in getting local jurisdictions to incorporate VRP.

- Opposition to VRP appears to be part of a larger backlash against excessive governmental interference in local affairs.

- Of the three states that have passed laws mandating VRP, two have compliance deadlines that have not yet arrived, and of those, one may substantially weaken implementation requirements before the deadline passes.

- The actual language of each of the VRP laws varies widely. A few more years of experience in implementation may be needed before the best wording for a given objective may be identified.

The most appropriate policy mix for solid waste may be one that:

- allows multiple options. Communities could either implement variable rates as part of an approved menu of items, or elect to design a set of programs and initiatives to meet legislated goals. This allows for local flexibility, recognizes the importance of local conditions, and allows options to reduce regulatory burdens on large and small communities.

- encourages study of variable-rate pricing feasibility and promotes implementation if waste-diversion goals are not met.

- makes funds or incentives available for the study or implementation of variable-rate pricing.

- includes small size, lower-cost container (or bag) requirements in the definition of variable-rate options. Variable-rate programs in which the smallest containers are 60- or 90-gallons undermine many of the inherent benefits from VRP.

- requires clear variable-rate signals to be reflected to the customers.

VI. EVALUATING PROGRAMS

Historically, comprehensive evaluations of the impacts of recycling, waste diversion, or rates programs have not been conducted in solid waste. It may be that the programs are too new, or that the programs have not been subject to scrutiny. However, in the very near future, program evaluation will need to come of age in the solid waste arena.

There are a number of important reasons to conduct a reliable evaluation of rates and programmatic options, include:

- providing justification for continuation of budgets;
- understanding the actual program impact and guide adjustments to the program;
- selecting the appropriate program mix and timing;
- improving data for decisionmaking;
- enhancing credibility of demand-side options; and
- fostering integrated planning.

Currently, program evaluation in waste management has received mostly lip service. However, defensible and credible evaluation techniques will need to be applied. Recycling and waste

management will not always be the "hot item." As these programs mature, and as municipal budgets become tighter and tighter, governments will require that the performance and cost-effectiveness of these programs be compared with competing demands for municipal funds, for instance increased police patrols, parks, and other governmental responsibilities. Continuation of subsidies and funding will be examined, and these programs will need to be evaluated in a credible way. Furthermore, it is important for solid waste agencies to understand the relative impact of various programs to identify the most cost-effective programs, to identify which programs aren't hitting targets and need adjustments, and to guide further integrated planning efforts.

Evaluation of performance of variable rates and recycling programs is still at a somewhat crude level. The majority of evaluation efforts reported thus far take the form of:

- our recycling program has high "participation," therefore it must be successful; or
- our recycling program has high tonnage, so it must be cost-effective.

Neither of these arguments provides reliable or compelling evidence of program effectiveness. In a debate over program budgets, these arguments would leave a solid waste management agency very vulnerable to analytical challenge. Appropriate techniques have not yet been applied but are essential and must be used if the programs are to be considered on an even ground with supply-side options. In order to assure municipalities that funds are being cost-effectively spent and to reassure solid waste agencies of their programs' merits, cost-effectiveness evaluations are essential. Further, because of the low implementation cost, many of the programs can withstand this evaluation, especially when compared with capital-intensive alternatives.

Significant efforts in developing appropriate, credible evaluation techniques have been expended toward evaluating energy conservation programs. These techniques, called "impact evaluation," have direct applicability to evaluating solid waste recycling and programmatic efforts.

"Impact evaluation" provides the estimated tonnage reduction attributable to the program, indicates how programs can be improved, and provides detailed data on the program that can be used for planning. It is designed to examine the program costs, the attributable program benefits (in tonnage), and provide a credible benefit-cost comparison for the program. It also allows a determination of whether the program has actually affected generation and disposal behavior beyond what would normally (or "naturally") have occurred without the program. Regardless of the precise approach, the four major steps involved are:

1) determine the number of eligible participants that participated;
2) determine whether the program significantly affected waste-disposal patterns;
3) establish whether the observed effects are attributable to the program; and

4) identify the net benefit and cost-effectiveness of the program.

The three most basic approaches to conducting an "impact evaluation" for solid waste are:

1) pre-post evaluation;
2) pre-post with control group; and
3) regression, or econometric analysis.

These three approaches differ in terms of their costs, data requirements, and analytical complexity. The selection among evaluation approaches will depend on the budget and data available, and the anticipated use of the evaluation results. A summary of the steps necessary to conduct an evaluation of a waste management program via the different methods is provided below.

A. Simple Pre-Post Analysis

- Identify representative group in the community.
- Measure tonnage before and after the program.
- Use a survey or other method to collect data on relevant changes within the household (household size, income, etc.).
- Examine the results for statistically significant changes, controlling for important items that have changed.

For example, a community may have found that, prior to introduction of a waste-reduction program, average garbage set-outs were 44 pounds per week, and after program implementation, the set-outs for those same customers decreased to 38 pounds per week. The difference, or "gross impact" is 6 pounds per week, and statistical tests would be examined to determine whether it is significantly different from zero.

The strengths of this approach are that customers can serve as their own control group, the analysis can be performed using relatively small groups, and it is not data intensive. The data collection should, however, be conducted over a long enough time period to remove seasonal effects, and the survey must control for important nonprogrammatic changes.

Although this approach is straightforward, it does not control for "natural market adoption"; that is, it assumes all recycling behavior is induced by the program. The approach below helps control for this problem by making comparisons with the behavior seen in a group of similar customers who did not receive the program.

B. Pre-post with Control Group

- Compare group in community that does participate (or "receive treatment") with a *similar* group that doesn't.
- Measure tonnage disposed before and after the program—measure all the relevant tonnages to estimate impact.
- Collect data to identify group changes.
- Compute the significance of differences to determine program impact (alternatively, the comparison group could be a community with the recycling program and a similar community without a program).

The difference between tonnages for the control group and the participant group should be compared in the "before" case to determine whether the two groups are similar or representative. Then, the calculation of the pre-program participant tonnage is compared with the post-program participant tonnage to determine the "gross savings." The pre-program control tonnage is compared to the post-program control group tonnage to determine the changes in tonnage that would have happened to customer tonnage without the program. The net savings due to the program is computed as the difference, as illustrated below.

The advantages of this approach are that it provides a simple method of estimating "net" impacts and adjusts for "naturally occurring," or non-programmatic changes in tonnage. The disadvantage of the approach is that a truly appropriate control group is often very difficult to identify.

Table 4

EXAMPLE OF PRE/POST

Group	Avg. Pre-pgm Tonnage Disp.	Avg. Post-pgm Tonnage Disp.	Avg. Gross Reduction
Participant	43.9 lb/wk	38.2 lb/wk	5.7 lb/wk
Control	44.1 lb/wk	43.6 lb/wk	0.5 lb/wk
Net Savings Due to Program:			5.2 lb/wk

Compare average gross tonnage reductions for groups and test significance with t-test.

C. Regression Approach

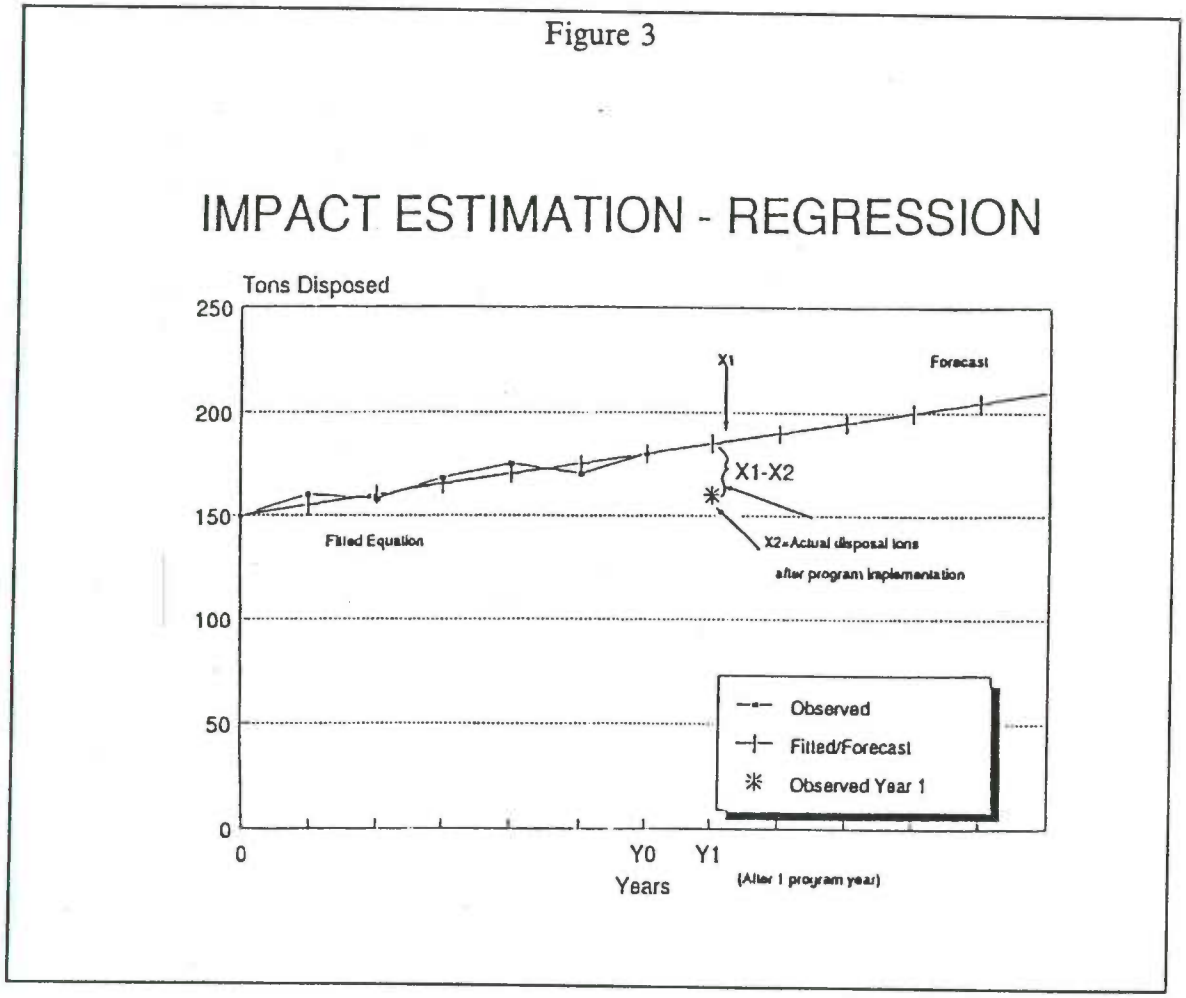
The most complicated of the options with immediate applicability to the solid waste arena involves the use of regression or econometric analysis techniques. To conduct this type of impact evaluation, the following steps are used:

- estimate tonnage reduction or disposal equation as a function of other variables (historical series for socio-economic factors, price, markets, etc.);
- collect information on the explanatory variables for the forecast, and collect tonnage and field information for the study period;

- use the equation to predict the tonnage that would have occurred and compare with the actual tonnage disposed; and
- examine the difference for evidence of an impact that is significantly different from zero.

The forecast would be based on actual conditions—the actual values of the explanatory variables. These tons would be compared with the program tons collected. The following graph shows the comparisons that would be calculated.

Figure 3



In evaluating the results, the following simple comparisons may be made. If x1-x2 is greater than the program tons collected, then there is evidence of source reduction, impacts of other programs, or model error. If x1-x2 is less than the program tons collected, then the program is collecting tonnage (and associated costs) from free riders, there may be diversion from private-sector efforts, the model may be in error, or other factors.

This technique provides the advantage that it does not require a control group; it allows behavioral factors to be included explicitly; and it allows projection of how changes in factors would influence program impact. The major disadvantage of this approach is that it is data- and analysis-intensive.

Any of these three methods would provide a measure of a program's tonnage impact.[23]

D. Evaluating Cost-Effectiveness

Using any of the techniques described above, a measure of the program's tonnage impact can be determined. The next step is to determine the stream of tonnage savings, and the valuation of the avoided costs from those impacts (or the "benefits"). This usually requires estimates of market prices, as well as the price (over time) of disposal. The costs of the program over time are also needed. Then, because costs and benefits may occur at different times, the net present value of all the costs and all the benefits must be calculated. The value of the net reduction in tons would be compared against the costs to determine if the program is cost-effective. Appropriate measures of cost-effectiveness include net present value, benefit-cost ratio, payback, and levelized cost comparisons. These measures help the analyst determine the appropriateness of the investment of funds and determine whether any adjustments are needed.

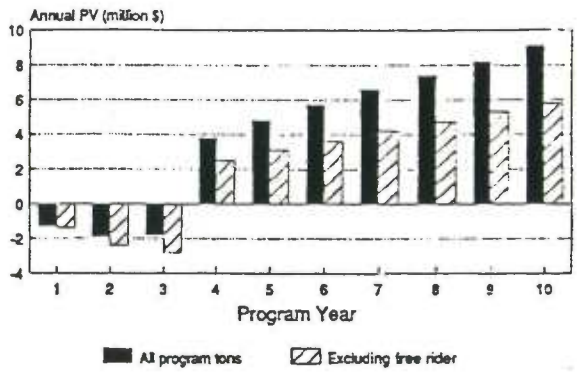
The evaluation of cost-effectiveness should, however, be calculated using benefits that exclude the tons that are diverted but would have been diverted without the program (called the "free rider" issue). The best methods for determining these exclusions include surveys, third-party data, experiments, or using results of a pilot program.

One example of this problem would be the case in which a curbside recycling program is implemented in a community that already had a great deal of private recycling. In this case, it is *crucial* to attribute only the *additional* tonnage collected (net of what used to be collected through private recycling efforts) to the program, but the *costs* side of the equation must include *all* the costs of running the program. This would provide the community with information on the costs of the incremental amount of waste diverted from the landfill, which is the appropriate comparison. An example is given in Figure 4. Including, then excluding the savings from the free rider tonnage can make a significant difference in the cost-effectiveness of a

Figure 4

NET PRESENT VALUE EXAMPLE

NPV $3 million vs. $0.7 million



program. Some existing programs (especially those that are convenient and expensive) may not prove to be cost-effective under this test.

Data collection, tracking, and monitoring are all activities that have lagged in solid waste, and should be required. Further, they should be included and built into program *design*, well prior to implementation. These activities would support program evaluation and would provide feedback to allow timely modification to programs and informed decisionmaking about the long-term cost-effective set of disposal options and rates.

VII. RANKING THE OPTIONS IN WASTE MANAGEMENT: THE ROLE OF VARIABLE RATES

The steps to carrying out these types of planning efforts can be fairly simple or can be supported by a detailed model that allows the community to consider all the details in planning program options. The steps include:

- conduct a comprehensive evaluation of the current system, determine current tonnage and composition, and current disposal and diversion by program/management method

- estimate the amount of tonnage that could be diverted by a number of programs and program design options. Include programs such as recycling, education, waste reduction, incentives, yardwaste, as well as other diversion and disposal options, and include expansions of current programs and activities.

- examine the interaction effects, or determine the tonnage "overlap," estimating the tonnage attributable to each program beyond the impact of the programs that would be assumed to be implemented prior to each of the considered program. Identify the "marginal" tons for each program, examining the ramp up assumptions, and the anticipated persistence of the option or program.

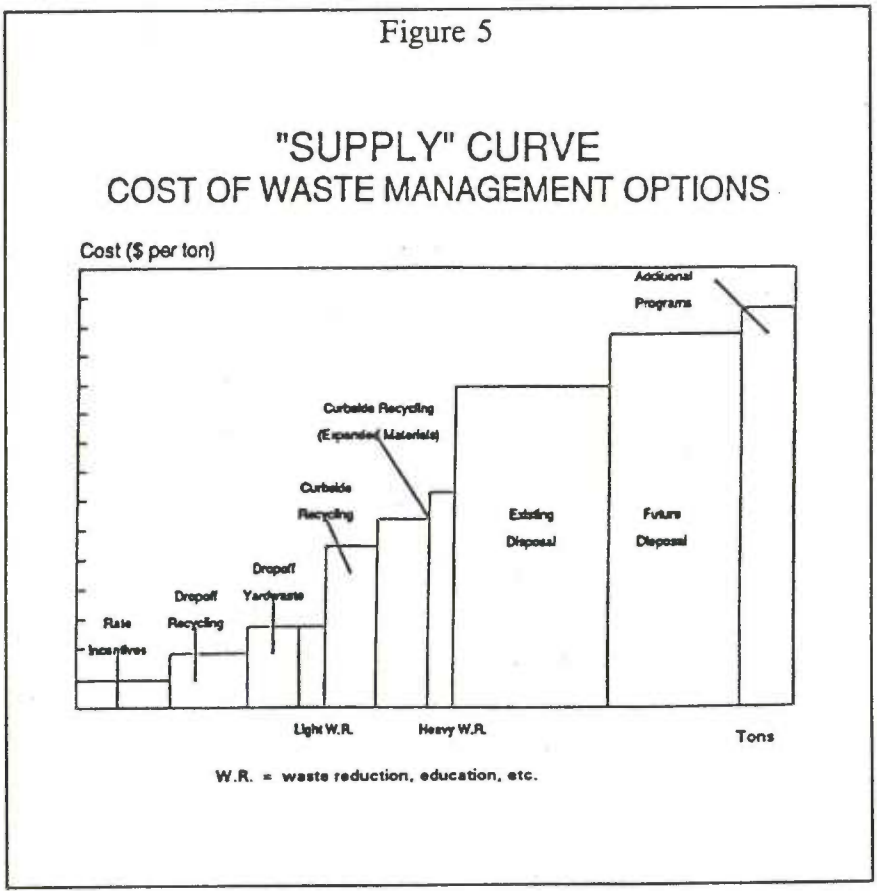
- estimate the costs (current and discounted future costs) associated with each of the programs. Using the total costs of the program, and the appropriate "marginal tonnage" attributable to the program, derive tonnage available at cost per ton for a variety of disposal options, including recycling, education,

- examine the cost-effectiveness of alternative management methods, valuing the costs and benefits in net present value terms.

- derive a "supply curve," ranking in order of cost, the amount of tons available and the price per ton for each of the management methods (including both programmatic and disposal methods). Incorporate "packages" of programs where necessary or appropriate.

This type of planning is now encouraged by comprehensive waste management initiatives in numerous areas of the county. Deriving a supply curve affords a community several advantages. It puts disposal and programmatic options on the same footing—cheap options that provide benefits only in outer years and expensive options with near-term benefits are valued appropriately. In addition, the jurisdiction is able to assemble a set of programs that makes long-term economic sense. Programs and alternatives can be selected with a solid understanding of the costs and benefits and the relative cost-effectiveness of options.

Figure 5



An example of the type of supply curve that can be generated is provided in Figure 5. The sample figure gives, in generic form, some of the relative costs of different waste-management program options for communities. It shows that one of the most cost-effective options that a community may consider is the implementation of a variable-rate system. It reflects the cost-eefectiveness of drop-off programs relative to curbside program delivery, but also illustrates that more tonnage may be available from more convenient programs. Notice that the cost of extensive recycling programs may indeed be higher than current, or even new, disposal facilities. It is important to consider, analyze, and rank a wide array of programs and alternatives (e.g., different material mixes) in deciding among waste-management options.

One of the reasons to carry out the steps of an *integrated planning process* is that it helps the waste agency determine the most *cost-effective* set of waste-management options. The relative ranking of programs will not be the same from community to community. The evaluation of programs must take into account local prices, conditions, and facilities, customer behavior, markets, collection systems, and numerous other factors that will lead to a "tailored" set of demand- and supply-side options. Some communities will decide that the *status quo* is appropriate in the long term. Most likely, many other communities affecting customer behavior will be more cost effective than continuing with the *status quo* collection and waste-management system.

In addition, it is important to determine that mix of options that is **cost effective and supportable in the long term**. Looking past transitional difficulties toward the long term public benefit can be examined explicitly in integrated planning activities. Also, the agency can determine those programs with short- or medium-term transitional difficulties that may be expected to be appropriate strategies in the long term—and an appropriate governmental role probably includes assisting long-term cost-effective strategies through transitional problems. This planning process may help governmental agencies to identify those programs and focus efforts and expenditures toward achieving the longer-term benefits.

Once the supply curve is generated, the selection among options is based on two main factors: economics and policy.

- Economics plays a role because communities generally implement the "least-cost" plan. Communities cannot generally afford to implement options that are not economic in the long-run, unless the community demands and is willing to pay for noneconomic options and is willing to pay for the length of time that the option is noneconomic.

- Policy plays a role in selecting between cost-effective options, in driving the timing of options, or in determining that some costs may not be appropriately valued, modifying the overall ranking of program options.

In fact, in the electricity case in the Northwest, policy goals were used to modify the results of the economic analysis—because of perceived benefits beyond pure economics, conservation programs were given a 10 percent cost advantage. That is, if a conservation program were 10 percent more expensive than the next generating resource, the conservation program would be preferred. Similar incentives have been or can be adapted for solid waste management options.

Increasingly, the case studies available show that variable rates can be a very cost-effective option, as well as an option that is flexible and can be quickly implemented. The range of types of communities adopting variable rates is growing.

One of the most important advantages of variable rates is that it helps provide a way for customers to see the relative priorities and relative costs of their waste management behavior. The use of well-designed price signals can provide a more-integrated picture of the waste management options to customers and educate them to make informed waste management decisions.

However, there is still a resistance on the part of many communities to implement "demand-side options," particularly variable rates, over tried and true engineering approaches.

- Programs and incentives use "softer" assumptions in planning and rely on changing customer behavior. Information from case studies and on persistence of the behavioral changes is not as plentiful as information on engineering approaches.

- The costs and results from engineering facilities (disposal facilities) are usually fairly well known or readily and clearly estimated based on extensive experience. Their performance has been assumed to be reliable.

Other factors also play a role in these decisions.[24]

Until better information (and information over a longer time period) is available on demand-side options and variable-rate alternatives and until rigorous evaluation techniques are applied, it may continue to be perceived as inherently "riskier" for a community to opt for a demand-side option rather than a landfill or incinerator. However, information from more and more communities with actual experience witht the systems, indicates that demand-side options may indeed be less expensive waste-management options for communities and customers.

The dilemma is, then, how to encourage communities to consider these options more seriously, should they prove to be appropriate for the community. Based on our research, it appears that state governments have begun to take a lead in encouraging the use of more innovative waste-management approaches—specifically variable rates—for communities. These activities at the state level have had the effect of:

- increasing the credibility of the option, and providing "permission" for communities to consider these "riskier" options;
- encouraging use of the option and increasing case study and data availability; and
- providing manuals, workshops, and other activities to reduce information costs for communities considering variable rates.

This may be a very appropriate role for states to take in waste management—to assist in encouraging communities to examine options that may have merit in the longer term, and to

provide information and incentives for the transitional time until more data are available and the options become more widely accepted.

VIII. CONCLUSIONS

High landfilling costs have changed the world of solid waste. Simple waste hauling has been replaced by integrated waste management. Variable refuse rates can provide an incentive for solid waste customers to use waste services more rationally. A number of "nuts and bolts" issues can complicate the issue of rate implementation—rates are not the answer for everyone. But variable refuse rates are a powerful tool in the effort to provide waste services more efficiently.

Price signals are an effective way of influencing customer behavior. Specifically, charging refuse rates that vary with the level of waste disposed can bring the efficiency of market-style decision-making to solid-waste management. Variable rates can be part of a system that insures efficient use of an integrated package of solid waste services by pricing those services in a way that emulates market pricing and will induce market-like consumption behavior in customers of solid waste services.

The number of communities with variable rates has accelerated rapidly, and within the next year or two, hundreds more communities are expected to come on line. This is phenomenal growth from the handful of variable rates systems in the late 1980s to the current level of over 1,000 communities nationwide.[25] Several factors have led to this growth:

- rising landfill prices;
- increasing knowledge about integrated planning in the solid waste area;
- legislated or planned diversion goals;
- reports of successful VRP programs around the country; and
- legislative mandates that encourage or mandate variable rates.

State legislatures have effectively focused attention on the role that variable rates may play in integrated solid waste management. A number of features of successful legislation have been examined, and include:

- allowing flexibility in the way that communities comply with legislation, while requiring basic system parameters that assure that appropriate and real incentives will be reflected to the customers;
- encouraging study of the feasibility of variable rates at the community or regional level; and
- making incentives available.

Even though variable rates are a powerful tool for modifying customers' behavior, not every configuration of variable-rate system is appropriate for every jurisdiction's situation. Each of the major systems has advantages and disadvantages that need to be weighed in terms of the community's current system and future goals.

Finally, as community-implemented programs and rate options mature, the long-term cost-effectiveness of these programs must be evaluated using credible techniques. Simply stating program participation or providing a gross comparison of tonnage diverted is inadequate to assure that funds and efforts are being appropriately allocated. Several evaluation techniques were described that would support credible evaluation of program impacts, and these techniques should be applied as programs compete with other initiatives for scarce municipal budget funds.

In summary, variable rates are not a panacea for all communities and are, frankly, inappropriate under certain conditions. However, examining the suitability of variable rates on a community-level basis makes sense for communities considering their options for managing waste. As more communities gain experience, problems that were previously perceived as barriers are finding solutions. Sharing information on new design features has helped a number of communities design and tailor variable rates systems with local conditions in mind and has made for successful programs in a wide range of communities. The increasing number of communities implementing programs has led to increasing credibility of variable rates—with planners, haulers, customers, and politicians—as an important and viable part of a comprehensive plan for managing solid waste.

ABOUT THE AUTHOR

Dr. Lisa A. Skumatz is an economist and Vice President with Synergic Resources Corporation. She is the author of numerous articles, studies and manuals on variable rate charges for solid waste. She has worked with solid waste agencies across North America in integrated planning, forecasting, rates, and financing, and program planning and evaluation issues.

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ENDNOTES

1. See *Solid Waste Digest*, Volume 3, Number 5, May 1993. The monthly report calculates a national average on a weighted basis.

2. Project 88—Round II, *Incentives for Action: Designing Market-Based Environmental Strategies,* Robert N. Stavins, Project Director, a policy study sponsored by Sen. Timothy Wirth and the late Sen. John Heinz, May 1991, p. 67.

3. Solid Waste Program Development Unit, "A Guide to Volume-Based Fees for Garbage Collection" (St. Paul, Minn.: Minnesota Office of Waste Management).

4. Linda Good, "Annual Report on the Borough of Perkasie: Per Bag Disposal Fee, Waste Reduction, and Recycling Program for the year 1988" (Borough of Perkasie, 1989).

5. Daniel Blume, "Under What Conditions Should Cities Adopt Volume-Based Pricing for Residential Solid Waste Collection?" *Master's Memo Study*, Duke University, prepared for the Office of Management and Budget, Office of Information and Regulatory Affairs, May 1992.

6. *Mandates or Incentives? Comparing Packaging Regulations with User Fees for Trash Collection,* by Lynn Scarlett (Los Angeles, Calif.: Reason Foundation, May 1993).

7. Skumatz, Lisa A., "Econometric Findings in Solid Waste: Demand, Customer Choice, and Reactions to System Change," Draft Yale Working Paper, December 1992.

8. However, as an approximation, Seattle estimated that of the -1.4 price elasticity found for residential collection, roughly half might be attributed to increased private recycling activities, and another half might be appropriately attributed to waste reduction. See Skumatz, "Econometric Findings...," *op. cit.*

9. Reported in Sarah Stone and Ellen Harrison, "Residents Favor User Fees," in *Biocycle,* August 1991.

10. Terri Emmer, Jim Neidhart, and Christine Bennett, "An Analysis of the Effects of Volume-based Waste Disposal Fees on Consumer Behavior," unpublished paper, University of New Hampshire, Durham, New Hampshire, 1992.

11. *Ibid.*, p. 16.

12. Survey findings were reported in "Volume-based garbage collection fees; an analysis of 10 Illinois programs," by Jeanne Becker and Marilyn Browning, in *Resource Recycling,* March 1991.

13. Daniel Blume, "Volume-Based Pricing," p. 13 and Table 3.

14. *Mandates or Incentives? Comparing Packaging Regulations with User Fees for Trash Collection*, by Lynn Scarlett (Los Angeles, Calif.: Reason Foundation, May 1993).

15. Sarah Stone and Ellen Harrison, "Residents Favor User Fees," *BioCycle,* August 1991.

16. Lisa A. Skumatz, "Garbage by the Pound: The Potential of Weight-Based Rates," *Resource Recycling*, July 1991.

17. Touche Ross, "Waste Recycling Credits, Systems, and Mechanisms," prepared for the Department of the Environment, United Kingdom, March 1991.

18. Skumatz, Lisa A., and Breckinridge, Cabell, *Variable Rates in Solid Waste: Handbook for Local Solid Waste Officials,* June 1990, EPA, Washington DC.

19. Skumatz, Lisa A., and Philip A. Zach, "Community-Level Adoption of Variable Rates: An Update," *Resource Recycling,* June 1993.

20. From "Highlights of the Waste Not Washington Act," from the Washington Utilities and Transportation Commission.

21. There remained, however, some issues related to buildings that were *designed*, but not *actually constructed* to meet the code.

22. Note that this surcharge has not yet been implemented. Rather, a set of prescribed "activities" were defined that constituted "implementation," and surcharges have not yet been invoked. Among accepted activities were "programs" sponsored by the utility that offered incentives for meeting the codes associated with the MCS.

23. However, for completeness' sake, it should be mentioned that two primary difficulties or issues associated with any of these types of measurements are:

- can the results be generalized, either to other groups of customers, or other similar programs; and

- can the results or impacts be expected to persist over time? Can we assume that customers will continue these behavioral changes at a similar level over time?

24. Other factors include the following. 1) Demand side approaches (programs and incentives) do not eliminate the need for ultimate disposal of some amount of waste in traditional engineered facilities (landfills, incinerators, etc.) The cost advantages of

delaying the need for new disposal facilities (and the cost disadvantages associated with siting delays) are often not appropriately valued, leading to a bias away from demand side options. 2) Interest groups associated with engineered facilities are usually better organized and funded than groups with preferences for demand side options. 3) Environmental costs, siting, permitting, and delays are not always appropriately included in initial cost estimates for facilities at the decision-making stage.

25. Lisa A. Skumatz and Philip A. Zach, "Community-Level Adoption of Variable Rates: An Update," *Resource Recycling*, June 1993.