Volume-Based Waste Fee (VBWF): Effect on Recycling and Applicability to New York City

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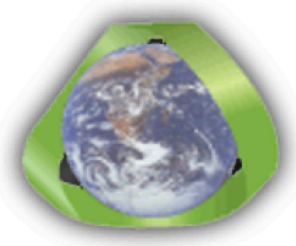

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EXECUTIVE SUMMARY

In 2011, the United States generated an estimated 389 million tons of municipal solid waste (MSW), or 1.3 tons per capita, of which 63.5% was landfilled, 22.7% recycled, 6.3% composted, and 7.6% combusted in waste-to-energy facilities. In most parts of the U.S., residents dispose their waste via curbside MSW collection. These collection and disposal services are traditionally funded by property taxes, where the costs are hidden, or from a per-household fee unrelated to the actual amount of MSW generated. Neither of these funding methods provides an economic incentive for residents to reduce waste or improve recycling.

A volume-based waste fee (VBWF) policy changes this model by charging households a metered price for the waste they generate. Implementation can be in the form of bin subscriptions with tiered pricing, mandates to use licensed bags, or requirements to attach licensed tags to each bag of waste. In these programs, curbside recycling remains free. In the U.S., forms of VBWF programs are active in 30 of the largest 100 cities, and apply to approximately 25% of the country's population. The number of communities using a VBWF system grew by 70% between 1998-2008.

By creating an economic incentive to reduce waste, VBWF programs can reduce the amount of rubbish destined for disposal by an average of 17%. Three factors contribute roughly equal amounts to this reduction: greater recycling diversion, organic waste composting, and top-line reduction in waste generation. In addition to providing an effective way to improve recycling, VBWF can help municipalities generate additional funds and allocate costs more fairly to those who generate the most waste.

The VBWF policy is adaptable to the variations in collection infrastructure and makeup of a range of communities. However, many municipalities struggle to apply metered pricing mechanisms to large multi-family dwellings, because residents can more easily ignore mandates and dispose of their waste without paying for licensed bags or stickers. This poses a challenge for cities such as New York, where a municipal fleet of collection vehicles services dense urban communities of high-rise apartment buildings.

This study examines ways in which towns, cities, and even an entire country have adopted forms of VBWF across a range of population densities and collection practices. Such programs are then analyzed for applicability to the unique logistical, administrative and political environments in New York City. Based on average VBWF results in other cities, and excluding potential growth in organic waste diversion, New York City could reduce waste disposal volume by 10-13% and improve recycling diversion rates by 5-6%. Such a program would help the City meet its sustainability goals while reducing the growing costs associated with waste collection and landfilling. A licensed bag program in New York City enforced on the building level, which requires no change in waste collection infrastructure, could save New York City approximately $145 million annually in collection and disposal costs. Based on proposed bag prices, such a

program could also generate on the order of $550 million of new revenue annually, providing the New York City Department of Sanitation with income equal to approximately 43% of its annual budget. Revenue from the sale of licensed bags could be offset by rebates on property taxes, which currently fund waste collection and disposal, to reduce political opposition to the new fees.

This study proposes a pilot program involving the Department of Sanitation and Columbia University to test the feasibility of the concept with building managers and measure the change in waste and recycling rates among an estimated 4,00 residential units in the Morningside Heights area of Manhattan.

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Introduction

This research study examines the economic, political and behavioral aspects of using a volume-based waste fee (VBWF) policy for increasing the rate of recycling municipal solid waste (MSW) among a diverse sample of cities. Also referred to as "pay as you throw" (PAYT), VBWF programs place a unit price on waste that residents generate, providing a market mechanism to encourage waste reduction and diversion to recycling programs. VBWF programs have been implemented in hundreds of towns and cities across the United States, as well as internationally. Implementation in U.S. municipalities has resulted in an average of 17% reduction in MSW volume sent to waste-to-energy (WTE) facilities and landfills due to greater diversion of organic waste, increased recycling diversion, and top-line reduction in rubbish generated.

This study investigates the structure of several VBWF policies and their effects on household waste disposal volumes and recycling rates. VBWF and recycling policies that target multi-family dwellings, which are traditionally laggards in recycling and waste minimization as compared to single-family homes, are a particular focus of the study. Following an overview of domestic and international cities that have implemented successful VBWF policies, this study examines the lessons and potential structure of such a program for the unique conditions in New York City, which is struggling to meet its ambitious residential waste reduction and recycling goals.

Definitions

Terminology in the waste sector varies between agencies, municipalities, and countries. For the purposes of clarity and consistency, this study applies the following definitions to research and policies that may use different nomenclature.

- **Composting**: Diverting organic waste from disposal for biodegradation and re-use as a soil amendment.
- **Disposal**: Materials discarded with no intention to recover materials for future use.
- **Diversion**: Recovering recyclable or compostable materials from the MSW stream which would otherwise be disposed.
- **Green waste**: Yard trimmings and other leafy or woody materials that can be biodegraded.
- **Municipal solid waste (MSW)**: Solid waste including rubbish, recyclables, and organics generated by households, institutional organizations, and commercial establishments.
- **MFD**: Multi-family dwelling.
- **Organic waste**: Biodegradable material that can be composted, including food waste, green waste, and soiled paper products.
- **Recyclables**: Commodity materials including glass, paper, metal, and plastics that can be diverted from disposal for use in new products.
- **Recycling**: Diverting glass, paper, metal, and plastic material from disposal for use in new products.

- **Rubbish**: Solid waste disposed at a landfill or processed in a waste-to-energy facility. Also known as waste, trash or garbage.
- **SFD**: Single-family dwelling.
- **VBWF**: Volume-based waste fee, a policy that charges a metered rate for waste disposal. Also known as also known as pay-as-you-throw (PAYT), "variable rate", or "user pay."
- **Waste-to-energy**: Processing rubbish as a fuel in a power plant that produces electricity, heat and scrap metals.

State of Waste & Recycling in the United States

In 2011, the United States generated an estimated 389 million tons of municipal solid waste (MSW), or 1.3 tons per capita. 63.5% of the country's waste is landfilled, 22.7% is recycled, 6.3% is composted, and 7.6% is combusted in waste-to-energy facilities, as reported in the Columbia University 2014 Survey of Waste Generation and Disposal in the U.S. Between 2008-2011, the amount of waste landfilled per year decreased by approximately 20 million tons while recycling increased by nearly the same amount. At an average landfill tip fee of $44/ton in 2008, the latest year for which national figures are available, landfill disposal costs $10.9 billion annually – a figure that does not include all the costs associated with collecting and transporting MSW.[1]

Traditional and User-Pay Models of MSW Disposal Financing

In most parts of the United States, municipalities provide a hauling service, or contract with private haulers to remove MSW that residents place curbside 1-2 times weekly. Property taxes or per-household fees generate funds to support collection, disposal, and recycling, residential costs that are unrelated to the actual amount of MSW generated. Neither of these funding methods provides an incentive for residents to reduce waste. In cases where MSW collection and disposal are funded with property taxes or flat per-household fees, residents are disconnected from the costs of MSW removal and disposal.[2]

Traditional funding for MSW removal and disposal insulates residents from direct and incremental costs for the waste they generate. As a result, many residents are not aware of the costs of waste disposal and see no financial incentives to generate less rubbish or increase recycling. These programs lack financial or behavioral mechanisms to change residents' behavior, leading to inefficiently high levels of total MSW generation and low levels of recycling.

The volume-based waste fee (VBWF) program, also known as pay-as-you-throw (PAYT), "variable rate", or "user pay," is an alterative to traditional mechanisms of MSW collection and disposal funding. The common factor across such programs is that waste generators are required

[1] Themelis, N, Shin, D. "Survey of MSW Generation and Disposition in the U.S." *MSW Management*, in press.
[2] Skumatz, Lisa A. "Pay as You Throw in the US: Implementation, Impacts, and Experience." *Waste Management* 28.12 (2008): 2778–2785.

to pay a non-uniform fee that depends on the amount of MSW they generate. Recycling for commodities and organics (often green waste and in some cases food waste) is provided at no charge. Such programs create an economic incentive for residents to generate less MSW in total, divert more of it for recycling, and minimize the volume of MSW (e.g. number of bags or bins) they leave for collection.

VBWF programs can reduce MSW generation by influencing behavior beyond direct financial incentives. In effect, VBWF ends the "all you can eat" model of traditional programs and implements an "a la carte" mentality, charging for additional increments of waste generated. This policy can make residents more aware of the effects of their consumption habits and change their behavior even when economic costs might seem otherwise relatively small.[3]

As presented in commentary by the C.D. Howe Institute[4], the main benefits and drawbacks of VBWF policies are as follows.

VBWF Benefits

- More equitable distribution of costs to those who use rubbish collection and disposal services the most
- Financial incentives to reduce waste generation in all forms
    - source reduction
    - increase in commodity recycling
    - increase in non-commodity recycling, such as composting
- Lack of behavioral mandates in favor of incentives
- Greater awareness of an individual responsibility to reduce waste and increase recycling
- Reduction in overall solid waste generation and environmental benefits for the entire community

VBWF Drawbacks

- Potential to place a financial burden on low-income residents or large families
- Creates incentives to illegally dump waste
- Uncertainty and volatility of revenue to support waste and recycling operations
- Start-up and recurring administrative costs
- Challenges to administration among multi-family dwellings (MFDs)
- Political hurdles

Adoption of VBWF in the United States

A confluence of factors is driving adoption of VBWF programs in communities across the United States. Rising costs for hauling and disposing MSW create pressures for municipalities to reduce MSW volumes and shift the costs onto the heaviest users. The programs can generate

[3] Bilitewski, Bernd. "Pay-as-You-Throw: A Tool for Urban Waste Management." *Waste Management* 28.12:2759, 2008.
[4] Kelleher, Maria. et al. Taking out the Trash: How to Allocate the Costs Fairly. Toronto: C.D. Howe Institute, 2005.

additional funds to support enhanced recycling programs. New technologies make individual metering feasible, with relatively low administrative overhead.

In the U.S., forms of VBWF programs cover approximately 25% of the country's population and are active in approximately 26% of the country's communities. This includes approximately 7,100 waste jurisdictions, including 30 of the largest 100 cities in the U.S.[5] Between 1998-2008, the number of communities using a VBWF system grew by 70%.[6]

Implementation and structure of specific VBWF policies can be tailored to the communities in which they will be operating. Because of the numerous ways VBWF has been implemented in communities across the United States and internationally, it is more appropriate to think of VBWF as a framework under which specific policies can be developed and implemented rather than a specific program itself.

Structure of VBWF Programs

The inherent flexibility of the VBWF framework means municipalities can design the parameters of specific programs to suit the needs of their communities. Most programs fall into one of the four following categories:

1) **Variable Collection Bin Sizes**. Residents choose a number or size of containers for curbside MSW collection. Residents are allowed to dispose only the amount of rubbish that fits in the bin. This is the most common type of VBWF program due to its simplicity for residents and compatibility with curbside collection fleets servicing communities of predominantly single-family dwellings.
2) **Licensed Bags**. Residents purchase licensed bags for rubbish disposal and any waste placed in unlicensed bags will not be collected. Funds generated by sale of the VBWF bags is used to fund the MSW collection and disposal or, as is more often the case, along with additional tax revenue. Because residents use the bags they purchase, there are few invoicing or inventory issues with this type of VBWF program.
3) **Stickers or Tags**. Residents purchase stickers and place them on bags of their choosing for MSW disposal. Each sticker represents a certain increment of MSW volume. Costs for stickers are often similar to those in licensed bag programs.
4) **Hybrid system**. Residents are charged a (lower) flat fee for waste collection, and for any additional waste that does not fit into the bin they must purchase licensed bags or stickers. For communities switching from flat-fee billing, this type of program can rely on a similar billing system while implementing a progressive fee that targets households generating the most waste.[7]

Another way to categorize VBWF programs is by the metering mechanism that determines incremental costs for residents.

[5] Skumatz, Lisa A., and David J. Freeman. "Pay as You Throw (PAYT) in the US: 2006 Update and Analyses." *Prepared for US EPA by Skumatz Economic Research Associates, Superior, CO* (2006).
[6] Skumatz, Lisa A, (2008), *op. cit*.
[7] *Ibid.*

Metering schemes can be categorized in three general groups:

1) **Per-Unit Service**. This includes systems in which residents purchase approved bags, tags, or stickers on an a-la-carte basis. Per-unit service provides the simplest "billing" mechanism because it eliminates the need for a municipal billing system, though it requires residents to purchase or order bags on their own.
2) **Subscription Service**. Residents subscribe to different levels of rubbish collection, often in the form of variable sized collection bins, and are billed the same amount each month. The larger the bin, the higher is the price paid by residents. This provides residents with simplicity through a steady, recurring bill, and can generate revenue with lower volatility than a per-unit service.
3) **Weight-Based Service**. Residents are charged for the mass of rubbish they generate, as measured by collection crews during curbside pickup. This service is precise and municipalities can alter adjust the per-unit pricing with greater freedom, but it requires collection vehicles outfitted with at least semi-automated collection technology, and wireless communication modules (e.g. Radio-frequency identification, or RFID) on both the vehicle and customer bins.

Though each of these models has benefits and drawbacks, the majority of municipalities using VBWF set up programs to charge variable rates for different sizes of trash bins because a bin-based curbside program works best for their community. Pricing for each size bin depends on the affluence of the community, hauling and disposal costs, and the amount of funds the government needs to collect to replace or eliminate contributions from property tax.[8] This subscription model is also compatible with a hybrid system, combining a flat fee to cover the fixed costs of trash collection and a unit-based fee based on bin size, which can help provide municipalities with greater revenue stability to cover fixed overhead costs.[9]

Net Effects of VBWF Program Implementation

Due to the wide-ranging nature of VBWF programs as implemented across the country, it is challenging to isolate a single policy or societal variable and determine the extent to which it contributes to reduction in MSW landfilled and the corresponding increased diversion to recycling or composting. Several studies have examined the topic, and while all agree that VBWF programs are beneficial, the magnitude of the benefit can vary, depending on how the question is approached.

In a nation-wide survey of VBWF programs, Skumatz Economic Research Associates (SERA) found that variable pricing programs decrease residential MSW by approximately 17%. These gains include 5-6% growth in diversion to commodity recycling, 4-5% increase in diversion to green waste composting programs, and 5-7% top-line decrease in rubbish generation by source-

[8] Skumatz, Lisa A, (2008), *op. cit*.
[9] Massachusetts Department of Environmental Protection. "Pay-As-You-Throw: An Implementation Guide for Solid Waste Unit- Based Pricing Programs." (2004).

reduction efforts.[10] Compared to the 17% reduction in mass, however, rubbish volume has been found to decline from 50-67% due to higher-density packing of waste in a smaller volume.[11] Mass versus volume decline represents an important distinction when a bag or bin represents a unit of revenue for a municipality.

SERA also found that VBWF programs were the most effective single change municipalities could make to their drop-off or curbside collection programs. Using statistical analysis that controlled for variation in programs and financial incentives, the results showed that implementing a VBWF program improved recycling diversion more than other factors, such as adding additional materials to the recycling collection stream, changing collection frequency, or other program modifications.[12] Though studies show VBWF is generally effective at reducing waste and improving recycling, it is most effective in communities that have a robust voluntary curbside recycling program established.[13]

A Green Waste Solutions survey of 228 New England communities compared 118 municipalities using VBWF to 110 municipalities with a traditional (non-VBWF) system, with both drop-off and curbside collection represented roughly equally. Municipalities using VBWF with curbside collection generated 49% less waste for disposal (467 lbs/person/year versus 918 lbs/person/year) compared to traditional pricing programs. Those using drop-off generated 53% less waste for disposal (422 lbs/person/year versus 890 lbs/person/year). Similar to the SERA analysis, reduction in MSW volumes was roughly equally attributable to increase in commodity recycling, increase in organic waste composting, and top-line reduction in waste generated.[14]

A 1997 mail survey of 1,025 recycling coordinators across the U.S., who represent over 20% of all cities in the country with recycling programs, showed that households recycle approximately 300 pounds more per year in cities using a VBWF policy. This outcome was statistically independent of other factors that influence recycling rates on an individual or community level such as income, education, type of materials recycled, availability of curbside recycling, composting program, years of landfill life remaining or level of resident support for recycling.[15] This survey provides further support for the effectiveness of VBWF, independent of other factors that would make a particular community especially receptive to progressive waste and recycling policies. This is important to note because it would be reasonable to question the success of VBWF in specific municipalities based on residents' preferences (such as environmental

[10] Skumatz, Lisa A. "Measuring Source Reduction: Pay as You Throw/variable Rates as an Example." *Report Prepared by Skumatz Economic Research Associates Inc.* (2000).
[11] Skumatz, Lisa A. *Variable Rates for Municipal Solid Waste Implementation Experience, Economics, and Legislation*. Los Angeles: Reason Foundation, 1993.
[12] Skumatz, Lisa A., Ph.D., 1996. "*Nationwide Diversion Rate Study—Quantitative Effects of Program Choices on Recycling and Green Waste Diversion: Beyond Case Studies*," Skumatz Economic Research Associates, Inc., Seattle WA / Superior, CO.; and Skumatz, Lisa A., Ph.D., 1999. "*Achieving 50 percent in California: Analysis of Recycling, Diversion, and Cost-effectiveness*," prepared for the California Chapters of Solid Waste Association of North America (SWANA) and Skumatz Economic Research Associates, Inc., Seattle, WA / Superior, CO.
[13] Folz, David H., and Jacqueline N. Giles. "Municipal Experience with' Pay-as-You-Throw' Policies: Findings from a National Survey." *State & Local Government Review* (2002): 105–115.
[14] Environmental Protection Agency, "Get SMART with Pay-As-You-Throw." Summer 2010 Bulletin, EPA530-N-09-001 (2010).
[15] Folz, David H., and Jacqueline N. Giles, *op. cit.* (2002).

concern) or governmental priorities (such as a crisis in landfill volume capacity), which would skew comparisons with rates in municipalities that have not implemented VBWF programs.

Internationally, a 2014 OECD survey of countries in which VBWF programs are implemented across at least 5% of the population – which covered Canada, Japan, Korea, the Netherlands, Sweden and Switzerland – found that households who pay for waste collection via PAYT systems generate between 16% and 20% less rubbish on average compared to households that pay through other means such as taxes or a flat service fee. This study controlled for social-demographic and attitudinal factors that affect waste and recycling, and included both drop-off and curbside disposal services. VBWF charges were found to work in part by channeling recyclables away from the waste stream, and were the second most important factor predicting waste prevention, following only residents' membership in environmental organizations.[16]

These studies all support the conclusion that VBWF is effective in reducing MSW volumes, although it is not always possible to separate the policy from other driving factors behind their implementation in a particular city or waste jurisdiction.

Challenges to VBWF Implementation

Municipalities seeking to transition from traditional property taxes or flat per-household fees for MSW collection and disposal face challenges that can be grouped into three sections:

Table 1: Challenges facing municipalities in VBWF program design and implementation[17]

Political Challenges	Implementation of new fees and equitable distribution of expenses in transition from property tax-funded program with invisible costs
	Disparate impact on low-income residents and large families
	Negotiations for additional sanitation worker responsibilities
Administrative Challenges	Start-up costs for administration, public education and enforcement team to encourage compliance
	Uncertainty and volatility of VBWF revenue in early years of a program due to changing behaviors
	Enforcement of laws for noncompliance or illegal dumping
Logistical Challenges	Limits on collection infrastructure (e.g. bins are not possible)
	New equipment and IT systems required for collection, metering and individual accounts
	High fraction of multi-family dwellings diffuses individual responsibility

[16] Palatnik, R. R. et al. (2014), "Greening Household Behaviour and Waste", OECD Environment Working Papers, No. 76, OECD Publishing.
[17] Batllevell, Marta, and Kenneth Hanf. "The Fairness of PAYT Systems: Some Guidelines for Decision-Makers." *Waste Management* 28.12 (2008): 2793–2800.

Political Challenges

- **Implementation of New Fees**
  Residents who are used to receiving "free" waste collection may oppose new fees. Because many curbside collection and disposal programs are funded through property taxes and are not visible as separate line items, the visibility of new VBWF costs can provoke resistance. Communicating the benefits of new revenue streams for metered service and reducing existing taxes that will be replaced by new revenue streams can help address the perception that the municipality is levying a "double tax". In addition, while concern about opposition to PAYT is a significant barrier for municipal governments, implementations involve less political risk than many assume.[18]

- **Disparate Impact on Fixed- and Low-Income Residents**
  Because waste collection charges represent a greater proportionate burden on fixed- and low-income residents than on higher income residents, such fees can be considered regressive. Several studies show that household waste generation is positively related to household income, meaning poorer households would spend less per household than more affluent households in absolute terms. But due to the financial burden VBWF fees can place on low-income residents or those living on fixed incomes, cities often choose to implement subsidies, exemptions and deductions for economically vulnerable households.[19]

- **Sanitation Worker Responsibilities**
  Unless performed by an automated system, such as RFID tags embedded in MSW carts, tracking and tagging noncompliant households can represent an added responsibility for sanitation workers. For cities using municipal fleets, new contracts may have to be negotiated to accommodate these tasks. Cities that use private contractors may have to amend contracts for the additional responsibilities assigned to collection crews.

Administrative Challenges

- **Start-Up Costs**
  VBWF programs can increase municipal administrative requirements, which may lead to higher staffing, billing, and operational costs. Cities have compensated for this by incorporating these new costs into the fees charged. In most cases, start-up costs, such as additional helpline operators and program enforcement, are more than offset by lower total MSW management system costs.[20]

- **Revenue Uncertainty and Volatility**
  Implementation of VBWF provides an immediate price incentive to reduce waste and increase recycling. Municipalities may need between several months or even several

[18] Cornell Waste Management Institute, "Roundtable Four: Pay As You Throw For Large Municipalities." Final Report (2001).
[19] Batllevell, M., and Kenneth H., *op. cit.* (2008).
[20] Kelleher, M., *op. cit.* (2005).

years to understand the steady-state revenue they will collect due to a lag in behavioral changes, and because residents may decrease MSW volumes more dramatically than expected.

- **Compliance Enforcement**
  Because of health and safety considerations with putrescible (i.e. food) waste in the MSW stream, simply "turning off" rubbish collection for non-complying residents or properties is often not an option, unlike other utility services such as water or electricity. Cities have found tickets or assessing fees to property tax bills as an effective method of ensuring that noncompliant properties pay their fees and any penalties.[21] In addition, many programs expand collection services for bulky items to reduce illegal dumping.

Logistical Challenges

- **Collection Infrastructure**
  While rural and suburban areas often have no trouble accommodating bins for curbside pickup, urban areas often rely on bags. As a result, the kinds of VBWF metering available for a given area (e.g. bins, bags, stickers, RFID-enabled trash chutes, etc.) can be limited based on physical constraints, leaving policy makers with fewer options than they otherwise could choose from to suit the community.

- **Metering Equipment and Subscription Services**
  While certain forms of VBWF are subscription-based, such as tiered rates for different bin sizes, many programs directly weigh the amount of MSW residents generate. This can be accomplished in a curbside program using RFID-embedded bins and a collection truck with an RFID reader and semi-automated side loader equipped with a scale. It is also an option for residents disposing of waste via trash chute or in a neighborhood collection bin. Both cases require integration with a subscription system where residents maintain an account balance or are automatically billed for volume of MSW discarded.

- **High Proportion of Multi-Family Dwellings**
  Multi-family dwellings are a challenge for VBWF because costs are not easily passed on to individual residents. Overcoming this challenge is addressed in the following section.

VBWF and Multi-Family Dwellings

Historically, communities with a high proportion of multi-family dwellings (MFD) have had difficulty structuring and implementing VBWF policies. This is a subset of a larger challenge MFD residents face with MSW and recycling, which affects building owners and municipalities.

The U.S. has approximately 98 million occupied residential units, 16 million of which are located in buildings or complexes with five or more units. Residents in these households are

[21] Cornell Waste Management Institute, *op. cit.* (2001).

often omitted from community curbside recycling programs because curbside collection is not suited to many MFDs, and waste services are typically provided by commercial waste haulers, not municipal government.[22,23] In addition, sorting recyclables can be limited by interior space, which tends to affect residents in MFDs more than those in single-family dwellings (SFDs), in large part because residents of SFDs can use exterior space to store larger amounts of recyclables between collections.[24]

In a 2001 survey of 40 sample communities across the United States, the Environmental Protection Agency found that on average, recycling rates for MFD residents are slightly lower than for households in SFD. Curbside recycling rates are 1.6% lower (14.6% for MFD compared to 16.2% for SFD). When both curbside and dropoff volumes are included, recycling rates are 1.4% lower (15.7% for MFD compared to 17.1% for SFD).[25]

Table 2: Multi-family and Single Family Dwelling Diversion Rates, 2001 (U.S. EPA)

Item	Mean	Minimum	Maximum	n
TONS/HH—CURBSIDE				
Multifamily Recycling	0.14	0.01	0.42	40
Multifamily Refuse	0.87	0.29	2.44	40
Single Family Recycling	0.23	0.05	0.66	39
Single Family Refuse	1.13	0.55	2.44	39
Yard Waste	0.28	0.01	0.65	27
% diverted—MF	14.6%	0.5%	37.3%	40
% diverted—SF Curbside	16.0%	6.0%	36.0%	27
% diverted—SF Yard Trimmings	16.2%	0.7%	32.8%	27
TONS/HH—CURBSIDE + DROP OFF				
Multifamily Recycling	0.15	0.01	0.42	40
Multifamily Refuse	0.87	0.29	2.44	40
Single Family Recycling	0.25	0.05	0.79	39
Single Family Refuse	1.14	0.55	2.44	27
Yard Waste	0.27	0.01	0.65	25
% diverted—MF	15.7%	0.5%	37.7%	40
% diverted—SF Curbside	17.1%	6.0%	32.3%	24
% diverted—SF Yard Trimmings	15.7%	0.7%	38.7%	25

This small gap in recycling, averaging less than 2%, indicates MFD residents are engaged with their local recycling programs. The impediment to applying VBWF to MFDs is not due to

[22] Environmental Protection Agency, "Complex Recycling Issues: Strategies for Record-Setting Waste Reduction in Multi- Family Dwellings." EPA-530-F-99-022, 1999.
[23] Cornell Waste Management Institute, *op. cit.*, 2001.
[24] Ando, Amy W, et al. "Recycling In Multifamily Dwellings: Does Convenience Matter?" *Economic Inquiry* 43.2 (2005): 426–438.
[25] Environmental Protection Agency, "Multifamily Recycling: A National Study." EPA530-R-01-018, 2001.

residents' unwillingness to recycle, but rather the difficulty of applying a variable pricing mechanism to each unit in a large building.

While small multi-unit complexes can be individually metered with separate curbside bins for each unit, larger multi-unit buildings often have a central dumpster, co-mingled bins managed by the building, or a rubbish chute. Due to co-mingling, it is not feasible for residents to be made directly responsible for each unit of waste they generate. Various approaches to solving this challenge have relative strengths and also practical impediments:

- Charging the building owner a fee for each unit of waste the building generates is possible by measuring weight, size or number of containers, or per bag. This provides a volume-based market incentive to the entire building, but does not affect individuals. Building management may apportion disposal costs equally to each housing unit, or pro-rate it on an area or per-resident basis, but individual households still remain insulated from the costs of their individual waste generation. Exemptions for low-income and public housing residents would likely be a practical necessity for this and the alternative approaches below.
- Requiring residents to use licensed bags or tags with an incremental price for each can encourage noncompliance. Waste is often difficult to trace to a single unit and building managers may not have the resources to closely monitor disposal habits of residences.
- "Proof of payment" systems, such as use of magnetic cards to gain access to rubbish chutes or dumpsters. These systems have a mechanism for weighing individual households' MSW, which can solve the potential for noncompliance that mandates requiring licensed bags or tags encounter. Infrastructure for these systems is not always available, however, and installation of new systems adds to the startup costs of a program.

Because of the above challenges, often it is impossible to apportion marginal disposal costs each resident in an MFD, hindering the metering effect of a VBWF program. As a result, proponents of VBWF systems may state that the policies are not a good fit with MFD, and recommend focusing on SFD.[26] Cities that have implemented otherwise successful VBWF policies, as varied as Austin, TX, Minneapolis, MN, Utica, NY, Worcester, MA, and Concord, NH, have focused the programs on SFD residents (sometimes including buildings with fewer than 4-6 units) and leave large MFDs to use dumpsters collected by private haulers rather than municipal workers.

This approach may be acceptable in cities dominated by SFDs and small MFDs (i.e. 6 units or fewer) but it leaves many larger cities with dense populations and a high proportion of residents living in large MFDs omitted from a unit-based MSW pricing program. Dumpster contracts at the building level do not provide a granular pricing mechanism, and residents are largely insulated from the costs of their waste. As examined in the following Section, cities have approached the challenge of VBWF for MFD in a variety of ways that take into account local infrastructure, existing policies, and the economics of their MSW and recycling programs.

[26] Skumatz, Lisa A, (2008), *op. cit.*

VBWF Case Studies

Assessing MSW and recycling data from a range of municipalities that have deployed VBWF can provide insight into the elements that make a VBWF program successful. Of particular interest are cities and regions with high concentration of multi-unit residences, which, as indicated above, can lag single-family homes in recycling and are resistant to many forms of VBWF market mechanisms for purely logistical reasons.

The following overview shows the diverse range of VBWF programs as implemented in low-density townships, dense U.S. cities, and an entire country. Each program is examined for policies and their results taking into account population and make up of inhabitants, tonnage of recyclables and MSW collected before and after implementation, and the financial incentives and revenues.

Grand Rapids, MI

Grand Rapid, MI was an early adopter of VBWF programs, implementing its first metered program for curbside collection in 1973. In 2012, the city completed a 10-year transition to a new program that offers a true "pay as you throw" approach, charging residents only when a waste bin is collected from their property. Refuse collection is offered once weekly. Recycling is provided for free every 2 weeks.

Grand Rapids has a population of 188,040 (2010 Census), with a density of 4,215 people/sq. mile. For curbside MSW services, the municipal government offers the city's approximately 65,000 households an option of three cart sizes (32, 54 or 96 gallons) embedded with an RFID chip associated with the resident's account. An RFID reader on the service arm of a semi-automated truck records a curbside pickup every time the "smart cart" is collected, and the account is charged. Residents pre-pay for the service, and the city debits from their account each time the cart is emptied. This program eliminates the need for billing and invoices because each resident is expected to manage the account online, through a phone service, or at the Public Services Department. Residents can receive text message or email alerts when their account balance is low.[27]

This program applies equally to SFD and MFD residents. For residents in apartment buildings, each unit is allocated one cart. Some landlords prefer to manage each resident's account and include the costs in rent and other charges. Other MFD residents manage individual accounts. No significant problems with illegal dumping have appeared as a result of this program.

Prior to the 2012 city-wide smart-cart rollout, Grand Rapids required residents to dispose of MSW in licensed blue bags, which cost $3 per 32-gallon bag, or subscribe to weekly curbside collection with variable prices for rubbish bins. Licensed rubbish bags are still available to residents, but the city has encouraged the bins by pricing the smart-cart collection approximately

[27] Hurt, James. "*City of Grand Rapids, Michigan RFID-Enabled Refuse & Recycling Program*." RFID Journal Live. Orange County Convention Center, Orlando, FL. 2 May 2013. Presentation.

33% less expensive. While retail outlets stopped selling City refuse bags in 2012, refuse bags continue to be available at City offices for the approximately 29,000 households that have yet to sign up for the smart-cart program.[28]

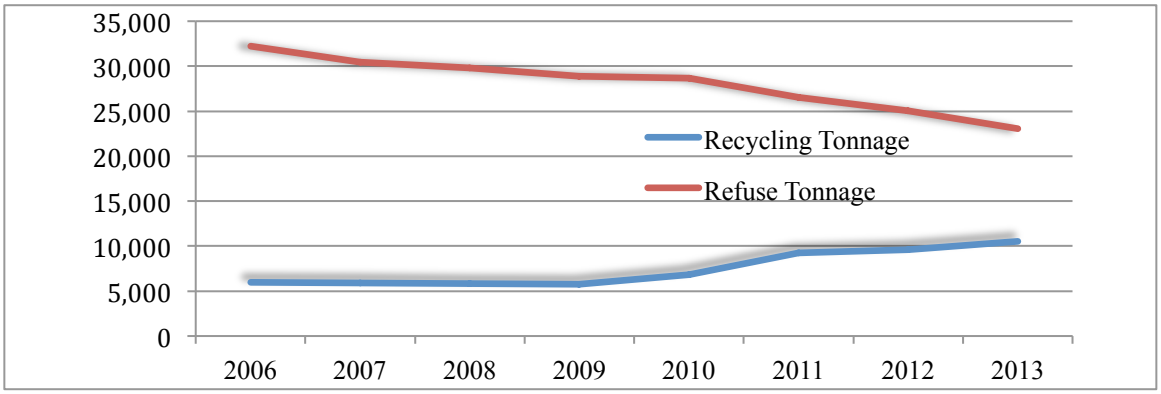


Figure 1: Grand Rapids, MI MSW and Recycling Volumes, 2006-2013 (City of Grand Rapids)

By eliminating the subscription service, the Grand Rapids, MI program eliminates the need for the city to send out more than 40,000 invoices each year. In addition, the city expects to save approximately $1 million annually from the reduction of printing and distribution of refuse bags. The city estimates total savings of approximately $1.27 million annually, and the program will pay for initial investments within 5 years.[29]

Table 3: Grand Rapids, MI MSW and Recycling Totals, 2006-2013[30]

Year	Tons of MSW	Tons of Recycling
2006	32,197	5,958
2007	30,436	5,918
2008	29,792	5,795
2009	28,890	5,751
2010	28,670	6,843
2011	26,558	9,209
2012	25,044	9,583
2013	23,052	10,508

The individualized financial incentives for waste reduction have resulted in 28% net reduction in MSW and 76% increase in recycling tonnage between 2006-2013. Further, the use of RFID at each household provides the city with data to analyze waste and recycling trends at the neighborhood level.

Grand Rapids views the program as successful financially, but aspects of the program have already been challenging. Grand Rapids' transition to smart-cart technology relied on investment in new bins and semi- or fully-automated collection vehicles, infrastructure that can represent a program barrier. In smaller cities, or those with different financing available, the capital expenses can make such a program cost-prohibitive. In addition, the city purposely priced the smart-cart option lower than the cost of licensed bags, but in doing so – and by creating a clear financial signal against MSW generation – volumes (and thus revenues) in the program's initial years were lower than expected. The Grand Rapids program lost $2 million in its first year of

[28] City of Grand Rapids Public Services Department, "City of Grand Rapids' Pay as You Throw, Smart-Cart, Curbside Refuse Collection Program." July 2012.
[29] Zetlin, M. "*The Economic Benefits of Going Green*." RFID Journal, May/June 2013.
[30] City of Grand Rapids Recycling and Refuse Data.

operation, and short-term loan was necessary as the volume of MSW shrank under the new program. Officials are considering increasing prices to bolster the program's finances.[31]

Sandwich, MA

Sandwich, MA adopted a VBWF using a bag and sticker program in 2012. The town, which has a population of 20,675 (2010 Census) and a density of 466 people/sq. mile, implemented the program as a way to mitigate anticipated increases in disposal costs when its contract with Covanta Energy was scheduled to expire in 2014. Disposal costs had been set at $37.51/ton for two decades, but under the new contract signed in 2013 the rate increased by 73% to $65/ton, escalating 2.5% per year thereafter, for disposal at the SEMASS waste-to-energy facility.[32]

To mitigate costs, the city implemented a hybrid VBWF program that raised funds and provided a clear price incentive to reduce MSW generation and increase recycling. This program is designed to provide 50% of the funds needed for MSW disposal, with the remaining provided by a tax subsidy.[33]

In structuring its program, Sandwich drew on the experience of the nearly 80 municipalities in Massachusetts that use a VBWF program for MSW and recycling drop-off; more than 50 additional municipalities use a metered curbside programs. Data from the Massachusetts Department of Environmental Protection (DEP) shows that on average, these towns and cities reduced their monthly per capita MSW volumes by 42% with VBWF.[34]

Table 4: Sandwich, MA MSW and Recycling Collection Volumes, FY2011-2012

Year	Rubbish	Plastic/Glass/Metal Recycling	Paper Recycling	Total Recycling
FY2011	5,328 tons	352 tons	890 tons	1,242 tons
FY2012	3,100 tons	614 tons	1067 tons	1,681 tons
Net Change	- 42%	+ 74%	+ 20%	+ 35%

The program in Sandwich is based exclusively on drop-off at transfer stations because no municipal curbside MSW collection is offered for either SFD or MFD buildings. Numerous local retailers carry licensed bags for waste, available for $0.25 (8-gallon), $0.60 (15-gallon) or $1.20 (30-gallon). Vehicles accessing the transfer station are still required to have licensed stickers, which are valid for one year.

[31] Cunningham, Daren. "$2 Million Loss for Grand Rapids "Pay-As-You-Throw" Program; Department Asked City for a Bailout." *Fox 17.* Tribune Broadcasting, 17 December 2013. Web. 11 December 2014. http://fox17online.com/2013/12/17/2-million-loss-for-grand-rapids-pay-as-you-throw-program-city-asked-for-a-bailout/.

[32] WickedLocal.com, "*Sandwich signs new trash-disposal contract with Covanta/SEMASS*." Gatehouse Media, Inc, 27 August 2013. Web. 8 August 2014. http://www.wickedlocal.com/x1803820661/Sandwich-signs-new-trash-disposal-contract-with-Covanta-SEMASS

[33] Tilton, Paul. "Pay-As-You-Throw 12-Month Update." Board of Selectmen Meeting. Sandwich, MA. 27 Sept. 2012. Presentation.

[34] Environmental Protection Agency, *op. cit.* (2010)

In its first year in operation, the program has reduced MSW volumes by 42%, and increased the recycling rate from 29% to 54%. Recycling of cans, plastics and bottles increased by 74%, and paper and cardboard recycling increased by 20% under the program.

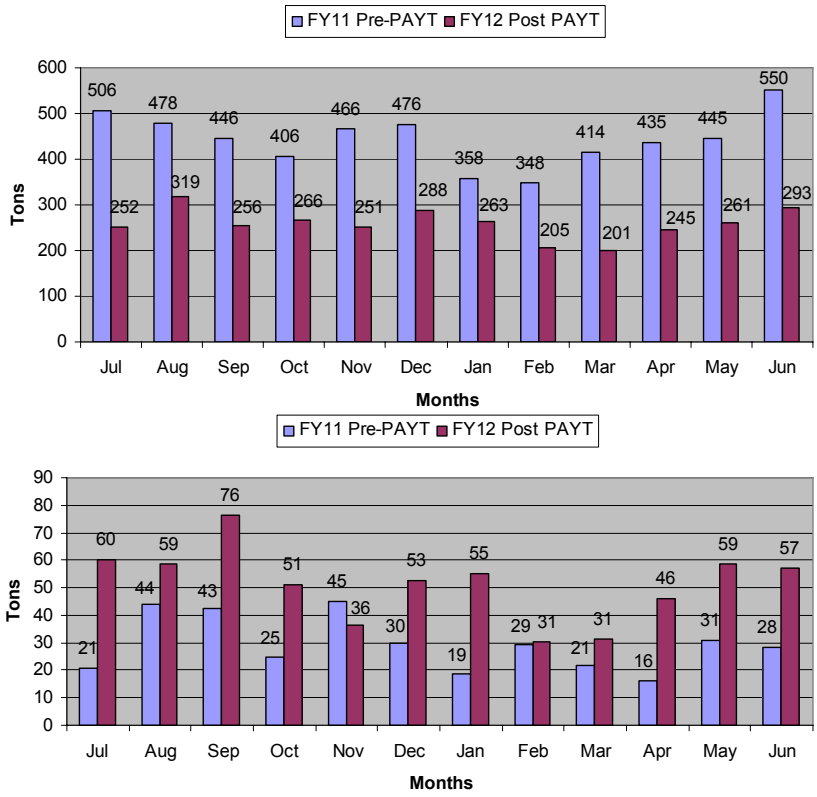


Figure 2: Sandwich, MA MSW Volumes (top), and Plastic and Metal Recycling Volumes (bottom) Before and After VBWF Program, FY2011-2012

Statewide, Massachusetts residents discard an average of 1.29 tons/person/year of MSW, which includes materials that end up in landfills, waste-to-energy facilities, recycled, or composted. [35] A city of Sandwich's size would generate 26,671 tons of MSW (waste and recycling) annually at state per capita average rates. Following the implementation of the VBWF program, the town currently generates only 4,781 tons – 18% of the state average. Although some of this may be attributable to a partially seasonal population in Sandwich, residents hauling waste to other disposal options than the transfer station, and exclusion of organics from transfer station data, the results remain striking.

From a financial perspective, in its first year of the VBWF program, Sandwich generated $371,410 from the sale of licensed bags. The town also saved $129,000 in solid waste disposal costs, approximately $6 per capita. With disposal costs set to rise by nearly 75% under the new contract taking effect in FY2014, savings will be even greater compared to the pre-VBWF waste generation rates.[36]

Moving forward, Sandwich plans to increase the cost of the bags and transfer station access stickers to cover the full cost of waste disposal. By FY2017, the town expects the waste and recycling program to be completely financially self-sufficient, covering 100% of the costs with bag and sticker sales and enabling it to remove the tax subsidy. At the start of the program, the transfer station fee had been reduced from $110 to $55 to encourage program participation, but increases in this fee will eventually cover the costs of operating the transfer station.[37]

[35] van Haaren R. *op. cit.* (2010)
[36] Tilton, Paul. *op. cit.* (2012)
[37] WasteZero, "Sandwich Recycling and Waste Reduction Excels With New Pay-As-You-Throw Program." WasteZero. 8 October 2014. Web. wastezero.com/about-us/press-releases/sandwich-succeeds-with-new-pay-as-you-throw-program.aspx

Additional benefits include reducing hauling traffic and vehicle drop-off frequency at the town's transfer station. With transfer station traffic reduced by 19%, the town can reduce staff and may be able to operate with fewer hours, saving even more money.[38]

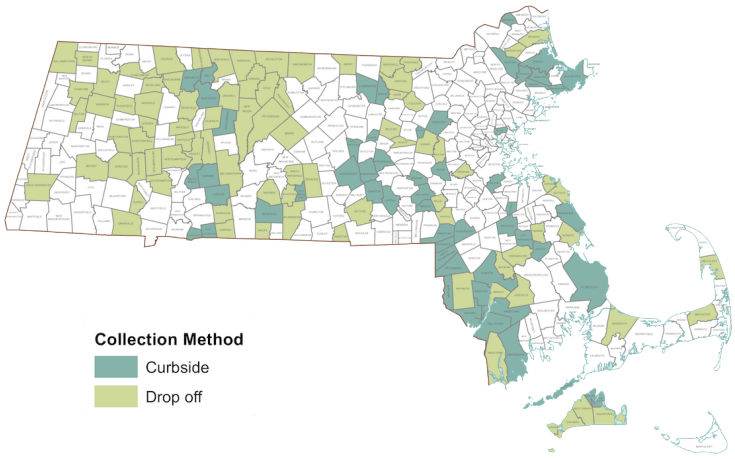


Figure 3: Approximately 1/3 of Massachusetts Municipalities Uses VBWF (Massachusetts Department of Environmental Protection, 2014)

In recent years, the Commonwealth of Massachusetts has promoted adoption of VBWF in cities and towns across the state, particularly through a program administered by the Office of Energy and Environmental Affairs. The results in municipalities that have implemented VBWF are nearly as striking as progress in Sandwich: communities without a VBWF program in place dispose of approximately 55% more trash per capita than communities that charge residents a variable fee.

San Jose, CA

San Jose, CA has implemented a comprehensive recycling program that addresses both SFD and MFD residents. With a population of 952,576, San Jose is the 10th largest city in the United States and it has a population density of approximately 5,360 people/sq. mile. 31% of its housing units are in MFD such as apartment or condominium complexes (2010 Census). Its success in increasing recycling and reducing MSW relies both on a VBWF program and contracts with private hauler that reward recycling over landfill disposal.

The city's original "Recycle Plus Program" (which included a VBWF mechanism) launched in 1993, in large part to meet California's mandated landfill diversion goal of 50% by the year 2000. Under the

PROGRAM SUMMARY	FY93	FY97
Tons Per Year MSW	NA	1,315,436
Tons Per Year RSW	283,000	433,576
Tons Per Year ICW	NA	881,860
Percent MSW Diverted	NA	43%
Percent RSW Diverted	33%	45%
Percent ICW Diverted	NA	42%
Average lbs./HH/day[1]	8.61	8.82
Net Program Costs/HH[1]	$206.85	$187.03
Disposal Services	$142.78	$81.95
Diversion Services	$64.07	$105.09

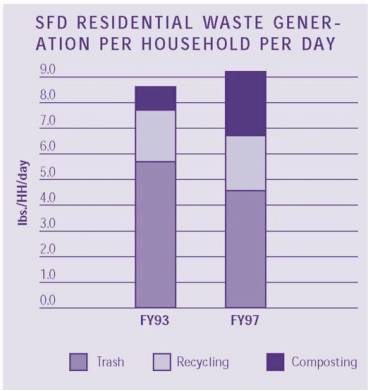


Figure 4: San Jose, CA Waste and Recycling Rates, FY1993 and FY1997 (US EPA)[39]

[38] Tilton, Paul. *op. cit.* (2012)

[39] US Environmental Protection Agency, Solid Waste & Emergency Response Document EPA-530-F-99-017o (1999)

program, which has evolved but maintains the core variable rate structure of the original program, the city contracts with four private firms for collection of waste and recyclables. These private firms operate in three districts and collectively provide services for 195,000 SFDs and 85,000 MFD units. The residential sector generates 32% of total MSW in San Jose, with 24% from SFDs and 8% from MFDs.[40]

Prior to July 1993, San Jose provided unlimited weekly rubbish collection service at a flat monthly rate of $12.50 per household. Without a price incentive to reduce waste, residents set out an average of three 32-gallon rubbish cans per week.[41]

The Recycle Plus Program was originally implemented only to SFD residents, and later expanded to include MFD as well. Currently, both SFD and MFD building owners subscribe to a variable sized bin for weekly MSW collection. SFD residents can also purchase extra stickers for bags of MSW for $6.25 each. Green waste and recycling collection services are provided at no charge.

Table 5: MSW Collection Monthly Rates for MFD, 2014 (City of San Jose)

BIN SIZE (cu yd)	1	2	3	4	5	EXTRA PICKUP
1	$ 104.16	$ 188.63	$ 273.13	$ 357.65	$ 442.16	$ 44.81
1.5	$ 130.81	$ 240.00	$ 349.20	$ 458.40	$ 567.58	$ 50.99
2	$ 158.17	$ 292.07	$ 425.98	$ 559.86	$ 693.74	$ 57.20
3	$ 211.61	$ 394.91	$ 578.19	$ 761.48	$ 944.74	$ 69.62
4	$ 265.08	$ 497.76	$ 730.41	$ 963.10	$ 1,195.79	$ 82.06
5	$ 318.51	$ 600.56	$ 882.65	$ 1,164.75	$ 1,446.81	$ 93.80
6	$ 371.97	$ 703.44	$ 1,034.89	$ 1,366.35	$ 1,697.83	$ 106.86
8	$ 478.85	$ 909.12	$ 1,339.33	$ 1,769.59	$ 2,199.84	$ 131.70

Table 6: MSW Collection Monthly Rates for SFD, 2014 (City of San Jose)

20-gallon cart	$29.08
32-gallon cart	$30.84
64-gallon cart	$61.68
96-gallon cart	$92.52

The Recycle Plus Program implementation for SFDs in FY1993 resulted in a 36% improvement in commodity recycling (from 33% to 45% diversion), and a net reduction in landfilled MSW of 21% (from 5.7 to 4.5 lbs/person/day) by FY1997.

As with other cities, San Jose has found it challenging to improve recycling rates in MFDs. Its VBWF program based on dumpster size and collection frequency provides financial incentives to owners rather than directly to the residents. The city states that its multi-family recycling and waste programs are difficult to implement because apartment dwellers are a more transient population with diverse language requirements. In addition, the MFDs often suffer from the "tragedy of the commons" problem, where no one takes responsibility for shared trash and recycling areas.

In 2003, the City's multi-family collection contractor achieved a diversion rate of only 18%, far below the contractually required 35% diversion rate. To boost volumes, the following year the

[40] "*Integrated Waste Management: Zero Waste Strategic Plan*," City of San Jose Environmental Services Department (2008)
[41] U.S. Environmental Protection Agency, "Pay-As-You-Throw Success Stories: San Jose, California," EPA530-F-97-007d (1997)

city's contractor sent 25% of MSW collected to a mixed waste recovery facility (a "dirty MRF"), separating out commodity recyclables and organics for composting. In July 2008, the City modified the diversion program for multi-family complexes again, to deliver all MSW to a mixed waste recovery facility. This program is intended to help San Jose achieve its goal of "zero waste" without the challenge of enforcing new recycling requirements for residents, property managers, and owners.[42] Success with the backend sorting program for MFDs piloted in FY2004 and implemented to all MFDs in FY2008 (Figure 8) helped San Jose surpass a 75% material recovery rate from multi-unit buildings.[43]

In addition to creating a price incentive for SFD residents, San Jose is also boosting its landfill diversion rates by inserting contract provisions with the four private haulers that serve the city. The city capped the costs that haulers can recover from fees per household at 80% of their estimated total system costs, and instead expect haulers to make money based on recycling: haulers charge $58-278 per ton of recyclables, and are able to sell the recyclables they collect (at an average of $50-60/ton, depending on commodity markets) as of 2002.[44]

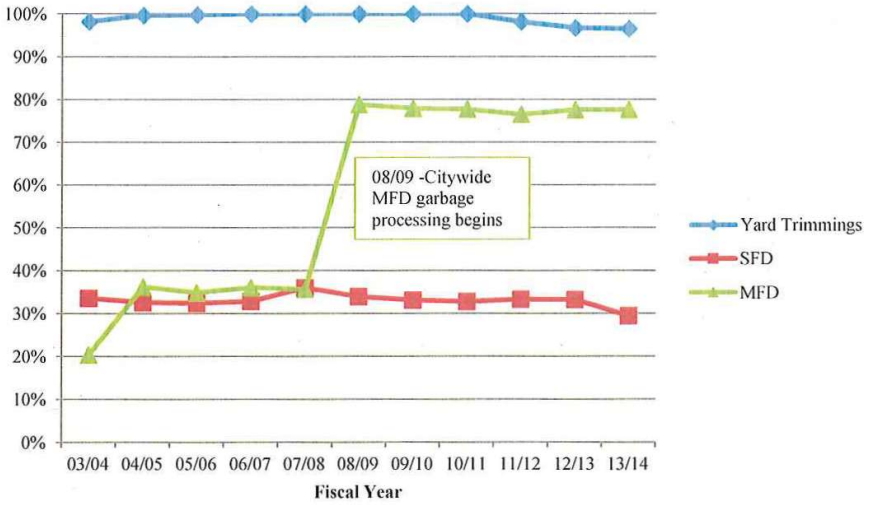


Figure 5: Residential Diversion Among SFD and MFD Residents, and Yard Trimmings Diversion (City of San Jose)

In addition to direct payments per ton of recyclables collected and revenue from the sale of these commodities, San Jose's contracts with haulers provide incentives for haulers to maximize the diversion of recyclables. These financial bonuses trigger when the following recycling targets are achieved: 35% for curbside recycling, 95% for yard trimmings (with a 50% compost requirement), 70% for multifamily rubbish, 50% for large item pickups, and 75% for neighborhood cleanups. In addition, for every 1% above the diversion standard that they achieve annually, haulers receive a bonus of 0.5% of prior year payments.[45]

As a result of the comprehensive waste and recycling policy in San Jose, which relies on personal incentives (VBWF), hauler incentives (financial rewards for diversion rates) and back-

[42] City of San Jose Environmental Services Department, *op. cit.* (2008)
[43] Romanow, K. *RecyclePlus Program Update* [Memorandum]. San Jose, CA: Transportation and Environment Committee. 21 October 2014.
[44] CalRecycle, "Incentive Programs for Local Government Recycling and Waste Reduction Case Study: San Jose." 21 June 2002. Web. 7 July 2014. http://www.calrecycle.ca.gov/lgcentral/library/Innovations/Incentives/SanJose.htm
[45] Rice, Elizabeth, "*How Do Our Cities Recycle?*" MSW Management. 10 June 2014. Web. 20 Dec. 2014. http://www.mswmanagement.com/MSW/Articles/How_Do_Our_Cities_Recycle_26011.aspx

end sorting ("dirty MRFs" for MFD waste), the city has achieved residential recycling rates of approximately 60% in recent years.[46]

Binghamton, NY

The city of Binghamton, NY, instituted a VBWF system in 1991, the same year it first provided curbside recycling services. Binghamton, NY has a population of 47,316 with a density of 4,517 people/sq. mile. 56% of its housing units are in MFDs (2010 Census). The city is unusual for curbside VBWF programs because it relies on selling licensed bags rather than subscriptions for variable-sized bins. The results of the city's program show the flexibility of VBWF in creating incentives for waste reduction and recycling diversion.

In 1990, the year before the licensed bag program was implemented, the city landfilled 26,027 tons of rubbish. In a single year, with the introduction of both a licensed bag program and the implementation of curbside recycling, the amount of residential rubbish dropped to 13,389 tons, a reduction of over 48%.

Binghamton's Department of Public Works made the decision to implement a licensed bag program in 1990 for several reasons. Disposal costs at the Broome County Landfill had risen at the beginning of 1990 to $35/ton, placing pressure on the disposal service that was funded through property taxes. In addition, city leadership sought a system that more equitably distributed costs and would provide an incentive for residents to participate in the then-new recycling program.

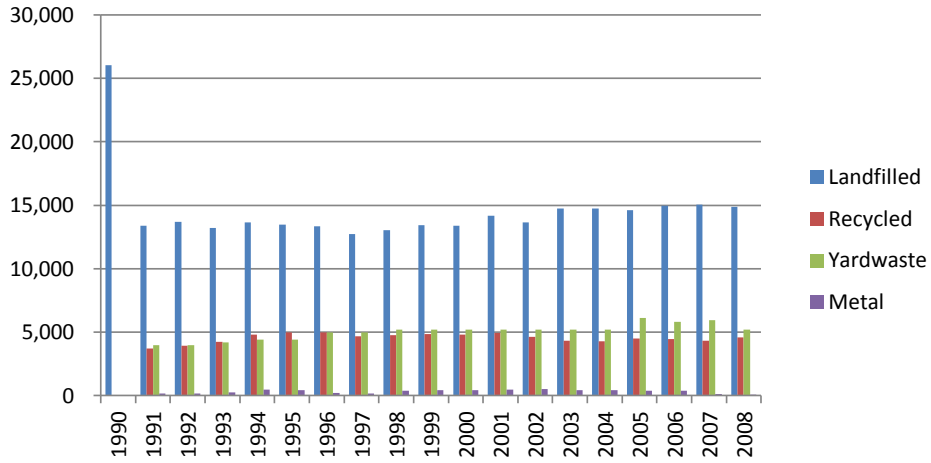


Figure 6: Binghamton, NY MSW and Recycling Volumes Before and After VBWF Program Implementation, 1990-2008 (City of Binghamton, NY)

After considering multiple programs, including a bag-based, sticker-based, and bin-based program at various prices, the city opted to sell licensed waste bags at a price that would cover all hauling and disposal costs by the municipal fleet that served residents, enabling it to remove the waste fee line item from its local taxes.[47] The program covers all residents, in both SFD and MFD, with the exception of any building that chooses to contract with a private hauler.

[46] Romanow, K. *op. cit.* (2014)
[47] City of Binghamton Department of Public Works, "*City of Binghamton Solid Waste Management Summary Report: 1990-2008*." (2013)

The price of bags has risen approximately 30% since the program's introduction in 1990. 30-gallon bags are currently $1.35, medium bags are $0.75, and small bags are $0.50.[48] Bags are available for purchase at a wide range of local merchants.

Table 7: MSW Generation, Diversion, and Disposal Costs, Binghamton, NY 1990-2008 (City of Binghamton Department of Public Works)

Year	Landfill (tons)	Recycling (tons)	Green waste (tons)	Bulk Metal (tons)	Recycling Rate	Landfill Cost
1990	26,027	0	0	0	0.0	$910,945
1991	13,389	3,700	4,000	180	37.0	$510,790
1992	13,687	3,934	4,000	157	37.2	$522,159
1993	13,227	4,238	4,200	250	39.6	$540,220
1994	13,655	4,800	4,400	500	41.5	$717,643
1995	13,492	5,000	4,400	442	42.2	$713,491
1996	13,338	5,000	5,000	206	43.3	$615,969
1997	12,741	4,675	5,000	166	43.6	$511,965
1998	13,050	4,747	5,200	400	44.2	$524,668
1999	13,416	4,836	5,200	447	44.0	$537,127
2000	13,399	4,816	5,200	440	43.8	$580,240
2001	14,179	4,961	5,200	479	42.9	$578,377
2002	13,656	4,652	5,200	543	43.2	$581,832
2003	14,748	4,333	5,200	433	40.3	$591,816
2004	14,755	4,293	5,200	420	40.2	$590,216
2005	14,602	4,515	6,136	373	43.0	$585,476
2006	14,956	4,441	5,800	406	41.6	$601,017
2007	15,052	4,315	5,950	126	40.8	$602,079
2008	14,884	4,585	5,800	75	41.2	$595,358

The city does not collect revenue from recyclables, but avoids a tipping fee by delivering materials collected curbside to Waste Management, which processes the commodity materials.[49]

Fines for noncompliance are approximately $30 per incident. Since 1991, the city has paid for at least two dedicated enforcement personnel to inspect waste and recycling, and cite any noncompliant residents. However, noncompliance in the form of illegal bags or illegal dumping has not posed a significant problem for the program.[50]

[48] WBNG, "Garbage Bag Fees Going Up," Broadcast Interactive Media. 17 November 2010. Web. 2 February 2013. http://www.wbng.com/news/local/Garbage-Bag-Fees-Going-Up-108839459.html
[49] W. Meredith, personal communication, 30 January 2013.
[50] City of Binghamton Department of Public Works, *op. cit.* (2013)

Republic of Korea (South Korea)

VBWF programs have been implemented around the world, and many countries are far ahead of the United States with policies that charge to dispose of rubbish to minimize waste and promote recycling. States in the U.S. are able to set independent policies, provided they comply with baseline Environmental Protection Agency standards, and historically most municipalities have maintained a high degree of latitude over the types of disposal and recycling policies they wish to implement. As a result, waste jurisdictions are able to develop programs tailored to their community, but lack the funding, economies of scale, or mandating diversion targets that would be provided by a national waste policy. The Republic of Korea (hereafter called South Korea) provides an example of the benefits of national policy for a country-wide VBWF program, as well as the adaptability across districts with different population densities and demographics.

In 1995, the government of South Korea introduced the country's first-ever national VBWF program to mitigate the growth of waste generated in the wake of the country's rapid industrialization and to extend the lifespan of existing disposal sites. Prior to this program, waste collection fees were charged on a fixed rate through property tax or monthly fee, independent of the amount of waste discarded. The VBWF program covers both households and small businesses (generating up to 300kg/day) using a bag-based program that imposes a unit cost on waste generated and provides a free recycling program.[51]

South Korea has a population of 49.4 million across 38,691 square miles, with a population density of 1,277 people/sq. mile. In 2010, approximately 57% of the population resided in apartment buildings or other MFDs, and 40% resided in SFDs.[52]

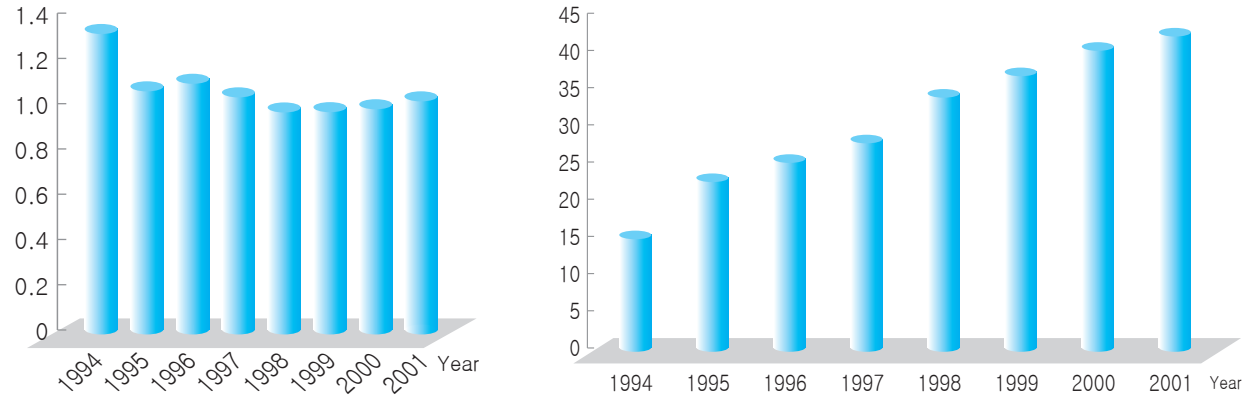


Figure 7: Per-Capita MSW Generation (left) and National Recycling Rates by Percentage MSW Diversion (right), 1994-2001 (Korea Environment Institute)

The VBWF policies implemented by the South Korean government – which have been tailored in cost and logistics to suit each region of the country – have significantly reduced the volume of

[51] Kim K, Kim Y. "2011 Modularization of Korea's Development Experience: Volume-based Waste Fee System in Korea," Korea Environment Institute (2012)
[52] Republic of Korea Population and Housing Census. 2010. http://kostat.go.kr

waste generated and improved recycling rates. In 1995, the program's first year in operation, total MSW dropped by 17.8% and recycling increased 26%. Between 1994-2004, the country has experienced a 14% reduction of municipal solid waste volumes from 1.33 kg/person/month to 1.03 kg/person/month, even as the economy continued to grow. [53] The portion of waste going to landfills or waste-to-energy facilities decreased from 84.6% in 1994 to 42.2% in 2007. Recycling rates increased from 15.4% in 1994 to 57.8% in 2007 (an increase aided in part by a 2004 requirement to separate organic waste for composting).[54]

Table 8: Change in MSW Generation and Recycling Volumes, 1994-2000 (Korea Environment Institute)

	1994	1995	1996	1997	1998	1999	2000
Total	58,118	47,774	49,925	47,895	44,583	45,614	46,438
Recycle	8,927	11,306	13.085	13,907	15,566	17,394	19,167
Final treatment	49,191	36,468	36,840	33,988	29,017	28,220	27,271
Generation per capita	1.33	1.07	1.11	1.05	0.96	0.97	0.98

Table 9: Average Price of VBWF bags in South Korea, 2006-2010[55]

Size (liter)	2006	2007	2008	2009	2010
3L	0.07	0.06	0.06	0.07	0.06
5L	0.09	0.11	0.11	0.11	0.11
10L	0.18	0.21	0.21	0.21	0.21
20L	0.36	0.41	0.42	0.42	0.42
30L	0.60	0.58	0.57	0.58	0.58
50L	0.89	1.02	1.04	1.04	1.04
75L	1.57	1.51	1.44	1.53	1.52
100L	1.84	2.04	2.09	2.10	2.10

(*US Dollars, exchange rate of 1,100 won to 1 USD*)

As part of the VBWF program enacted in 1995 and adjusted in following years, all residents are required to dispose of waste in licensed bags. These bags can be left curbside, where municipal governments provide collection services for SFDs, or in on-street bins for MFDs.

Early implementation of the VBWF included a pilot program in a handful of selected regions of 15 cities and provinces (each city and province selected 1 urban area and 1 rural area). During this trial, rubbish dropped by 40%, total materials diverted for

Figure 8: Waste Collection in Seoul, showing (left to right) waste bin, clothing collection, and food waste bins (Younjung Seo)

[53] Kim, K. *op. cit.* (2012)
[54] Asian Institute for Energy, Environment and Sustainability, "*The Volume Based Waste Fee System of Korea*," Yale University. 2013. Web. 8 September 2014. http://epi.yale.edu/indicators-in-practice/volume-based-waste-fee-system-korea
[55] Seo Y. "*Current MSW Management and Waste-to-Energy Status in the Republic of Korea*," Columbia University Department of Earth and Environmental Engineering MS Thesis (2012)

recycling increased by 100%. Success of the pilot program provided the government with confidence to expand the policy nation-wide. In the first year of the VBWF system's nationwide implementation, waste volumes decreased by 27%, and recovery of recyclable materials increased by 35%.[56]

Figure 9: A licensed bag for rubbish disposal in South Korea (Younjung Seo)

Financially, the South Korean government used the VBWF program as a way to bolster its finances. In 1994, the cleaning administration, responsible for solid waste management, generated only 14% of its operating budget through fees and other charges, with the remaining budget filled by local and national government funds. Even with a mature program in place, total profit for the cleaning administration (as calculated by sales of the bags and recyclable materials, plus fees for the disposal of bulky waste, minus production and distribution costs) are a minority of the annual cost of waste processing and disposal. Sales of the VBWF bags covered 30-40% of the cost of MSW hauling and disposal when the program was introduced in 1995, and this proportion has stayed relatively consistent since the program's inception. In 2000, the cleaning administration generated 29.6% of its budget from sales of VBWF bags and other disposal fees.[57]

Application of a Volume-Based Waste Fee to New York City

Overview of New York City Population

New York City is the largest and most densely populated city[58] in the United States. It has 8,405,837 residents and a density of 27,012 people/sq. mile. The City has 3,371,062 housing units[59], 50% of which are in multifamily buildings.[60]

The surrounding New York City Metropolitan area has a population of 22,085,649, with a population density of 1,865 people/sq. mile. The large size of the New York City, high share of MFD housing, and dense surrounding metropolitan area makes the City a unique market for MSW and recycling policy.

[56] Kim, K. *op. cit.* (2012)
[57] Kim, K. *op. cit.* (2012)
[58] Among cities with 100,000 residents or more
[59] U.S. Census (2010)
[60] National Multifamily Housing Council. "Quick Facts: Resident Demographics." NMHC. 2014. Web. 8 August 2013. http://www.nmhc.org/Content.aspx?id=4708

Generation and Costs of Waste and Recycling in New York City

New York City generates approximately 14 million tons of solid waste, including recyclable materials each year. To collect and haul this material, over 2,000 city-owned trucks and 4,000 private trucks operate for in-city collection.[61] Approximately one third of the 14 million annual tons – 10,800 tons of MSW and 2,000 tons of recyclable materials per day – is generated by households and institutional/public sector organizations and managed by the public Department of Sanitation (DSNY).[62] The remainder is generated by private businesses or the construction sector and is managed by private haulers. The focus of the following analysis is the fraction of waste managed by DSNY, which for residents is not metered in any way.

All New York City rubbish and recyclables are transported to local recycling facilities or transfer stations, where the materials are transferred to long-haul trucks, barges, or rail for processing or final disposal.[63] With the closure of the Fresh Kills landfill on Staten Island in 2001, New York City has brokered contracts for waste disposal at regional landfills and waste to energy (WTE) plants outside the City. The primary method of transporting waste from transfer stations is long-haul trucking, a system that moves 45% of DSNY-collected waste to landfills. 32% of rubbish is transported via railcar, and the remaining 23% is shipped shorter distances via the City's collection fleet.[64] As of 2010, the top three states receiving new York City rubbish were Pennsylvania (48% of the City's total), Virginia (31%), and Ohio (11%).[65]

DSNY receives funding through New York City's general city revenues, in effect paid for by property taxes and other fees levied across the City. Because these costs are invisible to residents and property owners, there is no incentive to reduce waste generation or increase the amount of materials diverted for recycling. Among other large cities in the U.S., only Boston and Chicago also fully fund solid waste management through general city revenues. Other cities levy various fees or tax line items that enhance awareness of the cost of waste and recycling services.[66]

The $1.28 billion DSNY budget for solid waste management in FY2012 equates to approximately $153 per resident. DSNY spent $299 million, 23% of its total budget, on exporting rubbish and recyclables to material recovery facilities, landfills, and waste-to-energy facilities.[67] The Citizen's Budget Commission (CBC) estimated that it costs DSNY $375 to collect and dispose of every ton of MSW (both waste and recycling): $251 per ton for collection and $124 for disposal. Cost estimates for recycling collection are $629 per ton.[68] These figures,

[61] The City of New York, "*PlaNYC:* A Greener, Greater New York – Solid Waste. *Update April 2011*."
[62] The Council of the City of New York, "*Hearing on the Fiscal 2014 Preliminary Budget & the Fiscal 2013 Preliminary Mayor's Management Report*," Department of Sanitation, 8 March 2013.
[63] The City of New York, "*Comprehensive Solid Waste Management Plan*." (2006)
[64] Sylvan, Derek. "Municipal Solid Waste in New York City: An Economic and Environmental Analysis of Disposal Options." (2012)
[65] Citizens Budget Commission, "*Taxes In, Garbage Out: The Need for Better Solid Waste Disposal Policies in New York City.*" (2012)
[66] *ibid.*
[67] The Council of the City of New York, *op. cit.*, 2013
[68] Citizens Budget Commission, "*12 Things New Yorkers Should Know About Their Garbage.*" (2014)

based on CBC analysis of DSNY, Bureau of Planning and Budget, Cost per Ton Analysis for Fiscal Year 2012, are higher than costs cited elsewhere because they include the full costs of DSNY services such as snow removal and street cleaning.

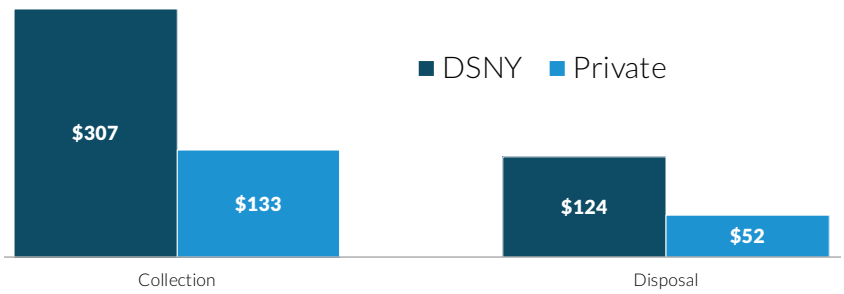


Figure 10: Cost per Ton for New York City MSW Collection and Disposal, DSNY and Private Haulers, FY2012 (Citizens Budget Commission)

Factors contributing to the high cost of waste and recycling collection and disposal include the inflexible rules by which DSNY collects waste. Trucks are always staffed by two DSNY sanitation workers, and the City mandates they provide refuse collection a minimum of twice weekly and recycling collection once weekly, regardless of MSW volumes. As a result, DSNY incurs significant labor and operational costs collecting materials at lower than optimal levels, and often has collection vehicles transport waste and recyclables at only 50-80% capacity. In addition, the City's use of dual-stream recycling, which separates metal, glass, and plastic waste from paper and cardboard, requires either two sanitation trucks to service the same route or a dual-bin truck to transport recyclables to separate material recovery facilities. These and other factors contribute to the cost gap between municipal and private-sector hauling and disposal costs, as shown in Figure 11.[69] Greater density of curbside materials would improve the cost-effectiveness of recycling by increasing utilization of the collection fleet and enhancing economies of scale for shipment and processing.

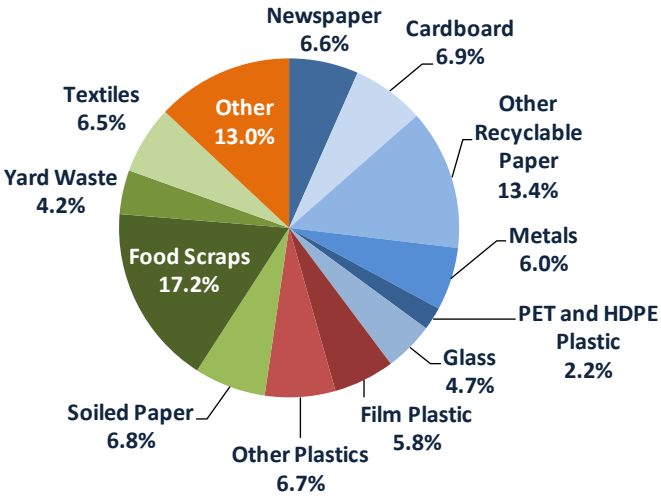


Figure 11: Composition of New York City Residential Waste (New York State Department of Environmental Conservation)

Waste and Recycling Generation in New York City

New York City's recycling rate among the residential and institutional sectors served by DSNY has been falling since 2005. In FY2014, the recycling rate for commodities – glass, metal, plastics, paper and cardboard – stood at 15.4%.[70] As shown in Figure 10, the rate peaked in 2002 at 19%, and plummeted the following year to just 11.1% when the City's recycling program

[69] *ibid*.
[70] New York City Department of Sanitation, "*Annual Report: New York City Curbside and Containerized Municipal Refuse and Recycling*." (2014)

stopped collecting glass, plastics and wax paper containers for one year due to the financial burden of recycling these materials.[71] The recycling rate took another two years to rebound, due to confusion this policy change caused among residents.

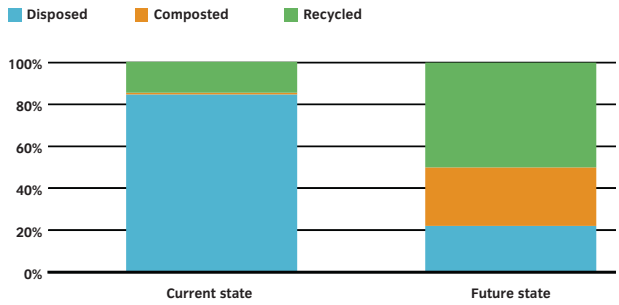


Figure 12: PlaNYC target for curbside recycling by 2030, compared to current state (Source: PlaNYC 2011 Update)

As shown in Figure 11, approximately 40% of residential MSW consists of recyclable paper, metal, plastic and glass. That figure improves to up to 52% recyclable if plastics #3-7 and film plastics are included, though they are more challenging to recycle than #1 PET and #2 HDPE plastics. An additional 28% is compostable organic material such as soiled paper, food scraps, and green waste.[72] Based on these figures, the sectors in New York serviced by DSNY recycle less than half the commodities that they could from the waste stream, and far less than the 80% potential limit if organic waste were diverted for composting or anaerobic digestion.

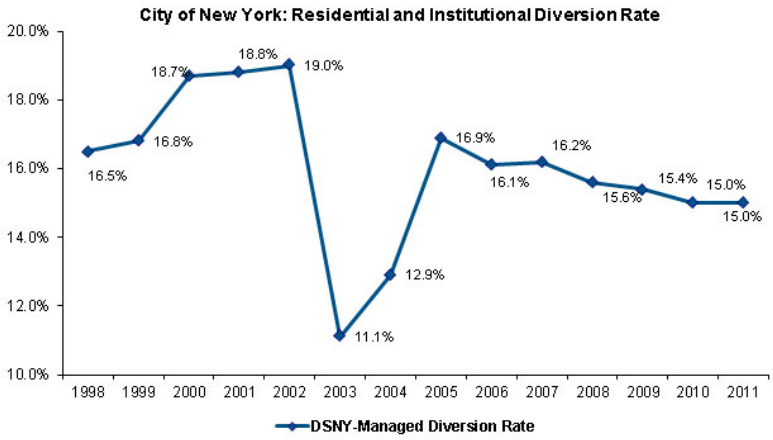


Figure 13: New York City recycling rates among residential and institutional sectors (Source: DSNY)

Despite the shrinking recycling rates among New York City residences, City agencies continually issue diversion targets that are both ambitious and, given current trends and limitations, unrealistic for the time frames forecast. For example, New York City's 2006 Solid Waste Management Plan, issued in a year when the curbside recycling rate was under 17%, committed the City to meeting a 25% curbside recycling rate target by 2007. The City's PlaNYC 2011 Update targets a curbside diversion rate of 75% by 2030, as shown in Figure 12, which would include commodity recycling of 50% of the waste stream (essentially 100% of all glass, metal, plastics, and non-soiled paper/cardboard present in the current residential waste stream) plus 90% of the total compostable fraction (food waste, soiled paper and green waste). Former Mayor Bloomberg's call in January 2012 to double the City's residential and institutional recycling rate to 30% by 2017 similarly appears both ambitious and unrealistic at current rates, despite pilot programs to compost organic waste collected in a new residential curbside program[73], the addition of new on-street recycling

[71] Cooper, Michael. "City to Resume Recycling Of Plastics." *New York Times* [New York City] 14 January 2003. Print.
[72] Citizens Budget Commission, *op. cit.* (2012)
[73] City of New York, "*PlaNYC Progress Report 2012: A Greener, Greater New York.*" (2012)

containers, and the opening of the Sunset Park Material Recovery Facility with a capacity of 1,000 tons per day of metal, glass and plastic recovery.[74]

Current Residential Recycling Laws

Curbside recycling in New York City is mandatory for all residents. In one- and two-family homes, residents must separate recyclables from rubbish, and they can receive fines for not separating recyclables, or for contaminating recycling bags or bins with rubbish, when materials are placed for curbside collection.

Owners and landlords of MFDs are ultimately responsible for their buildings' compliance with recycling guidelines. They must notify residents about recycling requirements, maintain an accessible area to discard recyclables, and post visible signs explaining what and how to recycle. They are also responsible for packaging recyclables in clear or blue bags, bins, or bundles (in the case of paper or cardboard) to distinguish it from rubbish. As in one-and two-family households, tenants must separate recyclables or face the potential for fines.

Recycling violations carry increasing fines of $25 (on first notice), $50 (on second notice), $100 (on third notice), and $500 (if four or more notices occur within a six-month period). Buildings with ten or more apartments that receive four or more Notices of Violation within a six-month period can be fined $500 for each bag that violates recycling regulations, up to a maximum of 20 bags within a 24-hour period (i.e. a maximum fine of $10,000 per day).[75]

Recycling-related violations issued in 2006, the most recent year for which data are available, totaled 143,902, generating a total of $3.2 million in collected fines. Recycling violations constitute over 25% of the total violations issued by DSNY in 2010 (143,902 of a total of 520,280) but generate only 10% of the violation-based revenues ($3.2 million of a total of $31.9 million).[76]

In practice, however, sanitation workers are not able to assess the contents of rubbish bags placed on the curbside for collection. Barring gross violation from residents, it is also nearly impossible for landlords or building owners to determine which residents of MFD are not properly sorting recyclables. The difficulty of levying fines for all but flagrant violations of waste policy, combined with lack of direct financial incentives for residents to maximize recyclables, are significant factors contributing to more than 50% of potentially recyclable materials being discarded with curbside rubbish.

[74] Website of the City of New York, "Mayor Bloomberg, Deputy Mayor Holloway and Sanitation Commissioner Doherty Announce Opening of New State-of-the-Art Recycling Facility - Able to Process Metal, Glass and All Plastics in One Location." City of New York. 12 December 2013. Web. 4 November 2014. http://www1.nyc.gov/office-of-the-mayor/news/914-13/mayor-bloomberg-deputy-mayor-holloway-sanitation-commissioner-doherty-opening-new/#/0

[75] NYC Recycles, "*Residential Recycling Violations*." The City of New York. 2014. Web. 22 November 2014. http://www.nyc.gov/html/nycwasteless/html/recycling/athome_violations.shtml

[76] NYC Independent Budget Office, "*Analysis of the Mayor's Preliminary Budget for 2008*." (2007)

Forces Shaping MSW and Recycling Curbside Collection in NYC

In many ways, New York City is a unique market when it comes to waste and recycling policies. The city is dense, relies on a standardized fleet of manually-loaded collection vehicles, and has limited flexibility in how and when to deploy its municipal sanitation workers. Forces shaping the current state of waste and recycling policy in New York City, and impediments to reforming the system, include political, administrative, and logistical factors.

Costs for curbside collection of MSW are currently hidden to both property owners and residents who rent. Not only does this remove incentives for recycling and waste minimization, it also can enable a sense that the City is responsible for waste disposal rather than it being a shared responsibility. Implementation of any new fees, whether direct per-unit charges under a VBWF program or a separate line item for MSW collection and disposal, are likely to face significant resistance if levied on individuals or property owners. A new policy that generates revenue by charging for waste, whether a flat per-unit fee or a metered VBWF program, would have to offset the current taxes allocated to MSW management rather than solely adding a new fee on top of current revenue sources.

Equitable distribution of any new itemized costs will be challenging given the range of wealth between different neighborhoods that use a functionally identical curbside collection service. For example, the 2010 Census tract in the South Bronx has an annual median income of $8,694, and a tract on the Upper East Side of Manhattan has an annual median income of $232,768, more than 25 times as high.[77] Large families would also bear the highest costs of a program that charged marginal costs for rubbish disposal. Residents in public housing through the New York City Housing Authority (NYCHA) and Section 8 housing cannot be expected to contribute equally on a per-household basis, due to their lower financial resources.

Politically, DSNY has limited flexibility in developing new collection policy or practices due to contracts with the city's municipal sanitation workers. This becomes a significant factor when assigning new responsibilities to sanitation workers, such as entering information about buildings in violation of waste and recycling guidelines during the collection route.

A high proportion of residents live in MFD, which are a challenge for recycling due to limited storage space in apartments and lack of personal accountability for curbside recycling separation. The density of the city, as well as the surrounding tri-state metro area, makes siting material recovery facilities a challenge and drives up costs for collection and transportation.

DSNY operates 1,666 rear-loading collection trucks, 405 dual-bin rear-loading trucks (for recycling), and 99 front-loading collection trucks for large bins.[78] Its fleet of rear-loading vehicles for MSW and recycling collection is uniform across New York City, both in neighborhoods where SFD are prevalent and denser parts of the City that are exclusively high rise apartment buildings. This fleet provides the department with flexibility in dispatching vehicles, and certain economies of scale for maintenance, but comes at the cost of limiting the

[77] U.S. Census (2010)

[78] Kattan, Spiro. "*Driving Towards a Cleaner Environment*." NYC Commercial Refuse Clean Truck Workshop. New York. 27 February 2014. Lecture.

adoption of new technology because the rear-loading vehicles must be filled manually, rather than semi- or fully-automated as are trucks used in other cities.

Storage of curbside waste is a challenge related to the uniform collection fleet. DSNY mandates that residents use bags for rubbish and recycling (with the exception of accepting bundles of paper and cardboard recyclables). Unlike other cities, totes and bins are not feasible with the density of the city and the prevalence of on-street parking. A 1991 pilot trial using waste bins showed intractable problems in moving the totes to the collection trucks because parked cars prevent access to the curb. As a result, New York City remains dedicated to a bag system for residential MSW, with manual loading of collection trucks.[79]

The density of New York City, and prevalence of organic waste in rubbish, makes MSW collection fundamentally a sanitation issue. With 17% of the typical residential MSW consisting of food waste, and no protective bins to keep vermin away from rubbish placed curbside, DSNY does not have the option to leave waste behind if a building is noncompliant with disposal guidelines (such as incorrectly mixing recyclables with rubbish). This may change in the future if residents begin separating organic waste from curbside rubbish. A voluntary pilot program for curbside organic waste collection, under Local Law 77, is currently testing the feasibility of sorting and composting residential food waste from approximately 100,000 New York City households between October 1, 2013 and July 1, 2015. It is unlikely, however, that curbside waste will cease to be a sanitation issue in the foreseeable future.

Finally, though the New York City curbside MSW collection program has its problems – in particular, a low recycling rate and high costs for collection and disposal – it is not currently an undue financial burden on the City. Supporting the DSNY's $1.28 billion annual budget costs each New York City household[80] approximately $380 (or $153 per resident), which is not significantly out of line for per-household costs when compared to cities that mandate individual bin subscriptions. (DSNY also serves schools and institutions in New York City, meaning per-household costs for residential MSW collection and disposal are below $380 annually.) New York City's low recycling rate is not critical to address as a purely financial matter, bas rather as a sustainability initiative and a hedge against the rising costs of landfill disposal in the future.

Structuring a New York City VBWF Program

The factors and constraints described above limit the potential structures for a New York City residential sector VBWF program. Any successful program must conform to the physical and logistic limitations of the City while also taking political considerations into account. It is especially important that a new program does not disrupt core elements of the residential MSW collection program:

- Maintaining reliance on bags instead of bins during curbside collection
- Using the existing manual rear-loading vehicle fleet
- Clear responsibility for policy adherence among building owners/managers

[79] Cornell Waste Management Institute, *op. cit.* (2001)
[80] U.S. Census (2010)

- A uniform policy that works for both residential areas dominated by single-family homes and denser neighborhoods of large apartment buildings.

Based on these limitations, options for the structure a VBWF program narrow considerably, but do not rule out the potential to introduce metered pricing for residential waste collection. Licensed waste bags, available for purchase, would be mandatory for residential waste. Recycling would continue as currently structured, and offered for free. Building owners/managers, rather than individual residents, would be ultimately responsible for compliance because there is no realistic mechanism to overcome the anonymity of residents in large MFDs.

Revenue from the sale of bags would supplement existing DSNY revenue streams under a hybrid VBWF model. The program could be structured to be revenue-neutral, or nearly so. Using revenues from the program to offset property taxes would make the program more politically feasible because property owners would receive a rebate (a lower effective tax rate) on the same order of magnitude as participation costs. At the same time, a fraction of the additional revenue could fund expanded recycling programs, public education, or other waste and recycling initiatives.

Approximately 620,000 New York City residents (7.4% of the City's population) live in public or highly subsidized housing. NYCHA maintains 178,557 apartments, and an additional 91,103 apartments are part of the Section 8 low-income housing program.[81] These households are ill-equipped to shoulder additional costs in a VBWF program, and building managers (as well as the agency owners) have limited methods to pass on costs. The effect of a VBWF program on these low-income residents must be considered.

A program structure that satisfies these demands and operates within the unique constraints of New York City is described below.

Proposed VBWF Program: Licensed Bags With Optional Subscription

In the proposed program, building owners/managers are required to purchase licensed DSNY bags for MSW disposal. Only licensed bags will be considered compliant for curbside collection. The bags are colored distinctly to promote awareness of the new program, and are semi-translucent to enable inspection of waste when examined from a close distance. Bags contain an official seal of the City of New York for easy identification among collection crews and visibility for residents. Bags are available in 30- and 45-gallon sizes, to conform to common bins for residential use. Recycling continues as currently structured, with building owners receiving free collection for properly sorted and bagged materials.

Licensed bags can be purchased through the existing DSNY site, hosted at www.nyc.gov, and at a range of retailers such as supermarkets, hardware stores, and convenience stores. The bags have a set price of $2 per 30-gallon bag, and $3 per 45-gallon bag, from both online and retail locations.

[81] New York City Housing Authority, "Facts About NYCHA." Fact Sheet. April 2014

Building owners can register for the VBWF program online. Their online account will link to existing databases maintained by the Department of Buildings, and it will allow DSNY to track information about each building's ordering and bag consumption for analysis purposes. Owners who register will receive a 10% discount on all bags they purchase, and an initial 5 free bags per unit (e.g. 100 bags for a 25-unit building) to begin the program, as well as posters for common areas and educational brochures to distribute to residents about the new program. As with current waste and recycling, owners may delegate responsibility for waste and recycling to managers or superintendents, but maintain final responsibility for complying with DSNY guidelines.

Using a tablet-based application mounted in the collection vehicle, DSNY will cite any buildings that do not use licensed bags for disposal during curbside collections. This system will be integrated with existing databases maintained by the Department of Finance. The address of the building will be entered; buildings that have registered online will receive both electronic and mailed warnings, while buildings that have not registered will receive a mailing with details of the infraction. After those notices of violation, there will be escalating fines for noncompliance, similar to existing levels: $25 on first notice, $50 on second notice, $100 on third notice, and $500 if four or more notices occur within a six-month period. There will not be fines for including recyclable materials in the rubbish, and building owners will have clear financial incentives to minimize the amount of material that requires licensed bags.

In this model, SFD homeowners are required to purchase licensed bags for rubbish disposal, but residents of MFDs are insulated from the costs of generating waste. Despite this, such a program would compel residents of apartment buildings to improve recycling and minimize rubbish by creating behavioral, if not financial, pressure.

Creating a clear financial incentive for owners of MFDs to minimize the total amount of waste they place for collection, and the number of bags they use, will indirectly influence residents' behavior. Building owners, currently responsible for the proper recycling in their buildings, will have every reason to prioritize recycling among residents by improving signage, collection areas, and communication to residents. Visibility of brightly colored bags in MFD collection areas and on the curb during routine collection will remind residents of the burden waste places on the City and the environment, and will compel them in ways both small and large to improve behavior.

From a program management perspective, MFD owners will also provide a smaller, more professional group for DSNY to engage, compared to mandating use of licensed bags for all MFD residents directly. While MFD residents maintain a level of anonymity with waste and recycling, on the building level enforcement mechanisms are clear and the City can identify the parties responsible for compliance.

Due to financial burdens among low-income housing residents and property managers, NYCHA and Section 8 building owners will be exempt from paying for the licensed bags, but will be required to use them to maintain consistency across the City and to build visibility for the program among all residences. The City will provide licensed bags to the managers of these buildings at no cost.

Benefits of Proposed VBWF Program

- The program uses existing City databases to manage subscriptions and track compliance/fines.
- The bag-based program is equally applicable to single-family homes and large apartment buildings.
- Registration is not mandatory, enabling building owners/managers to buy bags over the counter if needed.
- The program creates a clear financial incentive for building owners/managers to increase recycling and decrease material sent to landfills.
- With the price premium on each bag, there will be fewer trash bags set out on the curb. Currently trash bags cost very little, and the curb is often piled with many partially filled black bags.
- DSNY will be able to collect waste faster with fewer bags to handle. This will improve collection route efficiency and reduce disruptions to the flow of traffic
- The program will reduce the amount of plastic film in the form of trash bags.
- The City's sidewalks will be neater and freer for pedestrians with fewer, fuller bags placed out for collection.
- Building owners and superintendents will be motivated to post notices and encourage occupants to avoid putting recyclables in the trash bags.
- Low-income residents, and their building owners/managers, will be insulated from the costs of the VBWF program.
- Each brightly colored licensed bag on the sidewalk remind the public of the need to reduce waste, increase recycling and divert materials from landfills.
- The new revenue can be applied to improving waste management services, public education, and reducing property taxes.

Limitations and Challenges of Proposed VBWF Program

- Property owners will likely exert political pressure to maintain the status quo. The costs for waste services are included in the general fund, and homeowners and landlords may resist paying a perceived increase. This resistance may be mitigated by pledging the majority of revenue generated from bag sales to offset existing property taxes.
- The potential for illegal dumping increases if waste disposal becomes too difficult or expensive. Illegal dumping includes public street bins, parks, and other public spaces.
- Ticketing buildings for noncompliance will create additional responsibilities for DSNY sanitation crews and may require contract renegotiation with unions.
- Though records can be integrated with existing Department of Buildings and Department of Finance databases, this program will require DSNY to manage a new information system.
- Residents in multi-family buildings will be insulated from the direct costs of a VBWF fee and will not have an immediate economic incentive to reduce waste.

Estimated Effects on Recycling and MSW

The average VBWF implementation decreases residential MSW by approximately 17%: 5-6% growth in diversion to commodity recycling, 4-5% increase in diversion to green waste composting programs, and 5-7% top-line decrease in MSW generation by source-reduction efforts.[82]

There are several factors unique to New York City that will influence the success of the proposed VBWF program. The most important factor is insulating MFD residents from the direct costs of the VBWF unit pricing. Because residents will not have to pay for each licensed bag, the main factors influencing waste and recycling will be education-based. Education would take several forms: encouragement from landlords to recycle more; public awareness campaigns and advertising; and the visual effect of colored bags placed for curbside collection. But not all New York City households would be insulated from the costs because 50% of the City's households are single-family and would have to purchase bags online or from local retailers.

An additional factor includes the low current rate of recycling. Only 50% of the glass, metal, plastic and paper that could be recycled currently is diverted from disposal, based on MSW composition studies. This would indicate significant headroom for recycling rates to grow before reaching any fundamental limit on resource recovery.

Finally, organic waste diversion is difficult to predict. The voluntary pilot program for curbside organic waste collection, under Local Law 77, is in the early stages of testing the feasibility of sorting and composting residential food waste. The initial study will target up to 100,000 homes in neighborhoods across all five boroughs. It is too early to predict collection efficiencies and participation rates of this pilot, let alone a City-wide program. Beyond collection, large-scale disposal of organic waste will be challenging in the near-term. The Newtown Wastewater Treatment Plant may be able to accept up to 500 tons per day of organic waste, but to date has been accepting only 1.5-2 tons per day.[83] The Delaware Department of Natural Resources and Environmental Control has ordered the main commercial food waste contractor within reasonable distance of New York City, Peninsula Compost, to close operations by March 2015.[84] Even if source separation is feasible from a behavioral and logistical perspective, there may be nowhere to process this organic waste.

Considering these factors and results of VBWF implementation in other municipalities, for the proposed New York City program it is reasonable to assume no change in curbside organics collection, growth of 5-6% in recycling diversion (historic program average) and 5-7% decrease in total MSW (historic program average). The net effect would be a reduction of waste for disposal of 10-13%.

[82] Skumatz, Lisa. *op. cit.* (2000)
[83] Fletcher, Katie. "New York City scaling up food waste-to-energy program," *Biomass Magazine*. BBI International. 21 August 2014. Web. 2 October 2014. http://biomassmagazine.com/articles/10823/new-york-city-scaling-up-food-waste-to-energy-program
[84] Delaware Department of Natural Resources and Environmental Control. DNREC Secretary Small Orders Closure of Peninsula Compost Facility in Wilmington. State of Delaware, 21 Oct. 2014. Web. 3 Nov. 2014.

Order of Magnitude Costs and Revenue

For FY2012, the Citizen's Budget Commission estimated that it costs DSNY $251 per ton to collect waste and $124 to dispose of it. Cost estimates for recycling collection are $629 per ton, FY2012, while revenue from sale of recycled materials fluctuates with the commodity markets.[85] These cost estimates are higher than other sources, likely because they include costs for street cleaning, snow removal and other services into the per-ton costs of collection and disposal, but it is a reasonable starting point for cost analysis. For the purposes of this analysis, it is assumed that New York City earns $10 per ton of all recycled materials (the minimum for paper, and a conservative estimate for plastics and metal[86]).

Table 10: Waste and Recycling Volumes and Expenses Before and After Proposed VBWF Implementation, assuming 5.5% Increase in Recycling Diversion and 6% Decrease in Top-Line Waste

Cost Driver	Current Status	VBWF Implemented
Daily Tons Waste	10,800	9,558
Daily Cost of Waste Collection and Disposal	$4,050,000	$3,584,250
Daily Tons Recycling	2,000	2,110
Daily Cost of Recycling Collection and Processing	$1,238,000	$1,306,090
Total Daily Cost	$5,288,000	$4,890,340

Based on the CBC cost estimates, DSNY could save approximately $398,000 per day, or $145 million annually, by reducing rubbish 11.5% and increasing recycling 6%. This analysis assumes static collection costs per unit of waste and recycling, which is unlikely because collection crews would be able to collect recyclables more densely and could remove a portion of trucks from waste collection routes due to lower volumes. As a result, it is likely that marginal recycling costs would drop slightly, and marginal rubbish collection costs stay flat or would rise slightly.

For revenue, it is reasonable to project that 75% of buildings will register with DSNY online for a 10% discount. At this rate, DSNY would collect 92.5% of the face value of each bag, on average (i.e. $1.85 for every $2 30-gallon bag sold). In addition, projections must factor in the 7.4% of residents in NYCHA or Section 8 buildings who will not be paying participants. The Effective Unit Revenue below includes both the 10% discount for subscribers and the 7.4% of the population that will not financially contribute.

Table 11 calculations assume that all 9,558 tons of daily residential MSW will be contained in the bags, and the City's waste will be equally split between the 30- and 45-gallon bags.

[85] Citizens Budget Commission. *op. cit.* (2014)
[86] CBS News, "Is Recycling Worth It?" CBS Interactive. 26 April 2013. Web. 2 July 2013. http://www.cbsnews.com/news/is-recycling-worth-it/

Table 11: Potential Revenue from Sale of Licensed MSW Bags

Bag Size	Effective Unit Revenue	Unit Production Cost	MSW Weight Capacity	Daily Units	Daily Revenue	Net Income
30 gallon	$1.71	$0.15	20 lbs	477,900	$817,209	$745,524
45 gallon	$2.57	$0.20	30 lbs	318,600	$818,802	$755,082

Based on these initial figures, DSNY could generate approximately $1,501,000 per day in net income, or an additional $548 million annually. This represents approximately 43% of the DSNY's $1.28 billion annual budget. These figures do not include administrative costs or expenses for new IT hardware and systems, which would likely be trivial compared to the revenue generated. Costs incurred for enhanced enforcement, which would almost certainly be necessary in early years of the program, would also generate revenue from ticketing violators, which would help to offset the costs. The City also has significant flexibility in how it uses the new revenue. The program could be revenue-neutral by refunding an equal amount of property tax, to reduce political opposition. Or, if 80% of the program's net revenue were used to offset property taxes to make the program nearly revenue-neutral from the building owners' perspective, DSNY would be left with approximately $110 million annually for improved service, community outreach, and capital improvements.

New York City VBWF Pilot Program Structure

Discussions between Columbia University's Earth Engineering Center, Columbia Environmental Stewardship, and DSNY in 2012 and 2013 focused on how to create a pilot program that could prove the feasibility of a bag-based VBWF program in New York City. The questions were threefold: establishing a baseline level of waste and recycling for the study area; determining whether building owners/managers would comply with a mandate to use only licensed bags for MSW; and determining whether it was possible to change residents' behavior when the building, rather than the individual residents, was responsible for fulfilling the mandate.

Over the course of several meetings, a pilot program took shape that would provide both Columbia University and DSNY with data they judged valuable for their respective organizations.

Cathy Resler and Helen Bielak of Columbia University's Environmental Stewardship office sought information on the University's waste and recycling volumes. Columbia currently lacks granular information about the waste its buildings produce because DSNY picks up all waste in the area, including non-Columbia buildings. A pilot program on campus can provide data about the University's performance on waste and recycling, and internal trends.

Ron Gonen, former DSNY Deputy Commissioner for Recycling, expressed interest in determining the feasibility of a VBWF program based on licensed bags for waste. He sought initial data to prove the program's efficacy in reducing waste, increasing recycling, and garnering customer buy-in.

Currently, DSNY picks up almost all the waste and recyclables from Columbia, including on-campus buildings. A second contractor picks up extra cardboard and paper regularly, with a third contractor taking wet waste as needed. Off-campus, waste and recyclables are hauled from the curb just like every other building. Columbia owns over 7,800 apartments in Morningside Heights serviced by DSNY curbside.

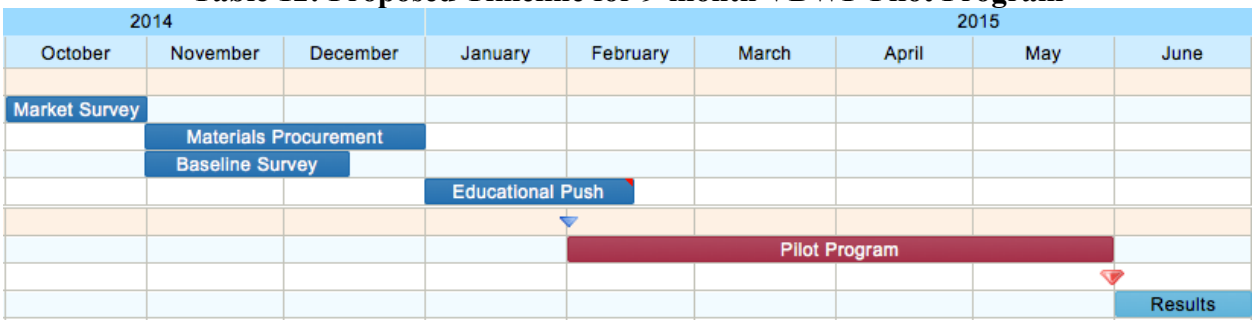
In terms of recycling and waste volume estimates, the best data currently come from extrapolating information from the Community Board volumes. The total recycling rate for Columbia-owned residences is estimated at between 30-35%, which Columbia's office of Environmental Stewardship believes is relatively accurate given the neighborhood rates, but is not a verified figure.

A pilot program would entail selecting a subset of buildings, totaling approximately 2,000 units. An initial assessment of the number of units per building would enable an estimation of the total number of bags needed over the course of a 4-month study period:

9 Month Pilot Program Timeline
Note that some tasks run concurrently

1-month **Market Survey** with superintendents about waste volumes and bag usage
2-month **Materials Procurement** for licensed bags and to organize materials for building-level activities
1.5-month **Baseline Survey**: Capture data from waste trucks serving Columbia, and perform on-street audits
1.5-month **Educational Push** in buildings and distribution of materials to superintendents
4-month **Pilot Program** measuring number of bags used and volume of MSW/recyclables collected
1-month **Results Analysis** to examine effects on waste and recycling, as well as feedback from building managers and residents

Table 12: Proposed Timeline for 9-month VBWF Pilot Program



In the pilot program, building superintendents would be assigned licensed, sequentially numbered 45-gallon bags, compatible with each building's communal waste bin. Volume for the waste would be tracked in two ways. First, tracking the number of bags used from each building would be a straightforward process due to sequential numbering. Second, DSNY would provide one or more trucks dedicated only to the study area during the pilot program, and would record

the aggregate amount of waste and recyclables generated. DSNY would collect waste in non-compliant bags for sanitation purposes, and would have a ticketing mechanism to record violations of participating buildings, though no fines will be levied.

No fees would be assessed for the initial pilot because it was not considered viable to charge superintendents for waste collection they are currently receiving as a municipal service. Instead, the motivating factor for participation would be a contest among participating buildings. Buildings that used the fewest number of licensed bags per unit, without recording violations, would receive a prize, as well as recognition from the University and local media. This program would also help assess which forms of communication to residents would be effective for a wider VBWF program.

With the broad outlines of a pilot program established, and demonstrated interest from the stakeholders whose participation is necessary for success, a trial of a VBWF policy in Columbia University housing requires a program manager who will re-engage the institutions and implement the program. In the 1980s, Columbia properties helped NYC successfully pilot its dual-stream recycling program, and the University expressed a strong interest in maintaining its position as an environmental leader with this new VBWF pilot study.

Conclusions

VBWF policies provide a straightforward market mechanism to allocate costs for waste collection and disposal more fairly among residents. VBWF offers an adaptable, flexible strategy compatible with municipalities' varied rubbish collection practices (curbside bins, curbside bags, or drop-off locations) and population types (rural, suburban, and urban). Implemented in over 25% of the communities across the United States, including 30 of the largest 100 U.S. cities, VBWF programs are appropriate for communities independent of their size. Implementation of VBWF in a community reduces rubbish volumes by approximately 17% on average by encouraging greater recycling, increased diversion of organic wastes, and reduction in the overall amount of rubbish generated. Despite the incentives for residents to illegally dump waste in these user-pay programs, communities using VBWF have not encountered any significant problems with compliance.

Developing the structure and pricing strategy of a VBWF program for a specific municipality takes time, commitment from the competent authorities, and engagement with the community. In addition to determining the formal structure of a program – collection method, pricing strategy, and enforcement mechanisms – municipalities must carefully consider the social factors of the implementation schedule, financial flexibility in the event of unexpected changes in the rate of waste generation, and community sentiment before implementing variable fees for rubbish collection and disposal. Communities interested in developing VBWF programs can draw on the lessons from similar towns or cities, refer to the Environmental Protection Agency's *Pay-As-You-Throw Tool Kit*, or consult with numerous companies who offer programmatic expertise to ensure their program is financially, socially and politically robust.

Maintaining consistency with existing collection practices is an important factor for municipalities implementing a VBWF program. Whether the community provides curbside collection services or requires residents to drop off rubbish and recyclables at a central location, maintaining a similar bin- or bag-based program when transitioning to a metered user-pay model can minimize disruption and eliminate the need for new capital equipment, such as improvements to the collection fleet. Consistency with existing physical infrastructure and daily residential habit minimizes start-up costs and facilitates a smooth transition to the metered pricing program.

Successful VBWF programs allocate costs and responsibilities consistently across the full residential population. This is in part a political consideration; the appearance of fairness in who bears new fees for rubbish is important for building community support. Application of consistent rules across all residents helps to ensure no one group is unduly affected by the pricing mechanism. It also enforces the idea that waste and recycling is an individual responsibility of every household, just as efficiency with electricity, heat and water use is considered an individual responsibility. Applying a single policy is simpler when the community is relatively homogenous, but it is possible to structure VBWF programs that account for differences, such as a mix of suburban and dense areas, while maintaining a sense of fairness among residents.

Community education is an essential component of VBWF program structuring and implementation. Residents often have legitimate concerns about the financial implications of VBWF, in particular that they will be paying an additional fee on top of taxes that fund existing MSW collection and disposal. Structuring the program as a revenue-neutral system, or at the least refunding a portion of funds collected in the form of rebates or tax relief, can mitigate resistance among residents to the new fees.

For New York City, key structural elements enabling VBWF are already in place. The City has control over the terms for residential collection, with DSNY providing service to both SFD and MFD residents. All buildings, whether SFD or MFD, are required to follow similar rules for sorting and bagging waste and recyclables. This provides a surprising consistency in residential waste and recycling policy in a city of over 8 million residents that spans communities of single-family homes to densely populated urban high-rise apartments. A bag-based VBWF program requires no change in waste collection infrastructure.

A New York City VBWF program that charges each residential building a unit price per bag of residential MSW will provide a clear price signal to improve recycling and minimize waste generation. Based on results in other cities, it is reasonable to assume that a New York VBWF program would result in growth of 5-6% in recycling diversion and 5-7% decrease in total MSW, resulting in a reduction of waste for disposal of 10-13%. Such results could save New York City approximately $145 million annually in collection and disposal costs and boost recycling rates to over 20%.

It is a reasonable conclusion that residents living in apartment buildings, even when insulated from the direct price their building manager pays for each licensed rubbish bag, would improve behavior. The motivation would be behavioral rather than economic: landlords would have clear incentives to encourage greater recycling in their buildings, and public awareness through

advertising and the licensed bags visible multiple times each week during collection would offer regular reminders for residents to develop a greater sense of individual responsibility for improving recycling and reducing waste.

The price of rubbish bags is both a political and economic consideration. At $2 for a 30-gallon bag and $3 for a 45-gallon bag, sales of licensed DSNY bags would generate on the order of $550 million of new revenue annually, providing the New York City Department of Sanitation with income equal to over 40% of its annual budget. Some or all of this revenue could be channeled to property tax relief, making the program nearly revenue-neutral from the perspective of building owners. Remaining funds could be directed to advertising, enhanced recycling programs, and capital improvements at DSNY or recycling service providers. Lower bag prices, such as the $1.20/30-gallon bags in the Sandwich, MA program, would provide a more palatable introduction to the program but the net financial effect on building owners would be similar; in a revenue-neutral (or nearly revenue-neutral) program, whatever building managers pay for bags they should receive as property tax relief.

VBWF is not the only way to improve New York City's meager 15% recycling rate. As seen in cities such as San Jose, back-end sorting of MSW to collect organic material and recyclables can improve diversion rates to approximately 75%. This approach requires new material recovery facilities for both commodities and organic waste, however, which are capital-intensive and can be difficult to site in the dense New York Metro area. The viable alternative to the existing status quo, charging building owners for each bag of waste, provides a mechanism to improve recycling rates and discourage waste generation with minimal up-front capital and administration costs. Requiring MFD owners to purchase licensed bags for curbside collection of their residents' rubbish is not a common VBWF strategy, but it provides a unique and effective solution suited to a unique city.

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