



# Potential use of feebate systems to foster environmentally sound urban waste management

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## Abstract

Waste treatment facilities are often shared among different municipalities as a means of managing wastes more efficiently. Usually, management costs are assigned to each municipality depending on the size of the population or total amount of waste produced, regardless of important environmental aspects such as per capita waste generation or achievements in composting or recycling. This paper presents a *feebate* (fee+rebate) system aimed to foster urban waste reduction and recovery. The proposal suggests that municipalities achieving better results in their waste management performance (from an ecological viewpoint) be recompensated with a rebate obtained from a fee charged to those municipalities that are less environmentally sound. This is a dynamic and flexible instrument that would positively encourage municipalities to reduce waste whilst increasing the recycling.

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## 1. Introduction

Most municipalities group themselves into associations in order to manage solid wastes in a more efficient way, avoiding duplication of services and facilities. Costs are allocated to each municipality according to some criteria such as the number of inhabitants or the amount of waste brought to the shared facilities.

These criteria very rarely take into account how ecologically sound the waste management practices of the municipalities are. Aspects such as the quality of the collection, environmental campaigns, or the degree of participation and commitment of the citizens depend on the environmental practices of local Councils.

In this framework, with different Councils making different efforts within the same association of municipalities, it makes sense to adopt a system to reward those municipalities that make significant steps towards ecological solutions for waste management, whilst penalizing those that do not move in this direction. In

the past, several proposals to articulate these incentives have been made (Taylor, 2000). In this paper the implementation of *feebate* systems is advocated.

## 2. Feebate systems

*Feebate* systems are aimed at fostering those activities, practices or products that are deemed more environmentally friendly at the expense of others that are less. They do so by means of a simultaneous use of both fees and rebates. The activities that take less care of the environment compared to the average are charged fees and the collected amount is transferred to the most ecological ones in the form of rebates, making them more competitive compared to the initial situation. The more environmentally harming an activity is the greater the fee is, and the friendlier it is the more it is subsidized by means of a rebate. An activity with the average environmental performance is not either charged or subsidized.

Globally, fees and rebates cancel each other out, and therefore this economic tool is neutral for the budget of the Administration that sets it up (Jansen and Denis, 1999), which only assumes the administrative costs of managing the system.

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As the impact by the agents being charged a fee will tend to diminish, so will diminish the average environmental impact. Since this average impact is the reference for the definition of fees and rebates, agents initially receiving rebates will no longer obtain them unless their impact on the environment decreases as well. Because of this ongoing incentive for all of the parties to improve their environmental performance, *feebate* systems are considered a dynamic incentive. The greater the fees and rebates, the greater the incentive and the environmental advances that will derive from the implementation of the system (Davidson and Michaelis, 1996). The possibility of *feebate* systems to be implemented with different instruments makes them a flexible and adaptable instrument.

There are scientific arguments to promote certain practices, both for environmental reasons (e.g. reduction of pollution, efficient use of material resources) and for economic ones (e.g. reduction of externalities, more efficient allocation of resources). However, the implementation of a *feebate* system depends not only on scientific arguments, but it is also a political and policy decision, since it implies a public intervention leading to a different distribution of economic burdens.

*Feebate* systems have already shown their possibilities. For example, they have been applied to discriminating vehicles according to their fuel consumption in Maryland, USA (Davis et al., 1997) or to fostering efficiency in buildings in California, USA (Lovins et al., 1998). Their implementation has been proposed in other areas such as pollution control, water consumption and energy conservation (Collinge, 1997).

### 3. Feebate system proposal for municipalities sharing waste treatment costs

The proposal developed below has been designed for implementation by associations of municipalities sharing treatment facilities. For each municipality different *feebates* will be calculated according to its per capita waste generation and the destination of each waste fraction. These *feebates* would be added to the current average cost pricing system.

If  $i$  is any of the  $p$  municipalities that are members of an association, and  $j$  is any of the  $q$  possible waste treatments (e.g. landfilling, composting, recycling...), then a *feebate* ( $fb_{ij}$ ) can be defined for each municipality and waste treatment as a linear function of the difference between the per capita waste generation of the municipality and the association:

$$fb_{ij} = n_j \times \left( \frac{t_{ij}}{pop_i} - \frac{\sum_{i=1}^p t_{ij}}{\sum_{i=1}^p pop_i} \right) \times pop_i \quad (1)$$

where:  $t_{ij}$  tonnes from the municipality  $i$  treated with system  $j$ ;  $pop_i$  population of municipality  $i$ ; and  $n_j$  constant defined for each treatment.

The proposal refers to a unique time scale, namely fees and rebates are charged and received annually.  $fb_{ij}$  can be either a positive (fee) or a negative (rebate) value.

According to the definition, for every treatment those municipalities with a generation equal to the average of the association would have a *feebate* equal to zero and would therefore not be affected by the system.

Defining a different  $fb$  function for each treatment  $j$  (using different  $n_j$  values) enables discrimination between each treatment to foster waste reduction and recovery. The sign of  $n_j$  determines whether the association encourages or discourages using a treatment. If the association wishes to discourage municipalities to use a certain treatment  $j$ ,  $n_j$  has to be positive, and vice versa. In both cases, the greater  $n_j$  (in absolute terms), the greater the incentive.

For the definition of  $n_j$ , life cycle analysis and environmental impact assessment should be used. Results would vary between regions. Since  $n_j$  values are relative to each other, the value for each treatment would also depend upon which other treatments are in place in the association of municipalities. Moreover, the  $n_j$  values would depend upon the political priorities. For example, if a certain composting level has to be achieved because of a legally binding goal, the  $n$  value for composting should be negative and high (in absolute value) in order to foster it in relation to alternative destinations.

Since the definition of  $n_j$  is the practical means whereby the association can specify the kind of waste management practices that it wishes the municipalities to implement, their calculation is a crucial point in the implementation of a *feebate* system.

Assuming that without the implementation of the *feebate* system each municipality would contribute to the association according to the quantity of waste brought to each facility, the basic amount to be paid by each of them would be:

$$(\text{payment without } fb)_i = \sum_{j=1}^q p_j \times t_{ij} \quad (2)$$

where:  $p_j$  price per tonne brought to treatment  $j$ .

With the implementation of a *feebate* system, the fees and rebates would be added above this basic amount. Therefore, the amount each municipality would have to pay to the association would be:

$$(\text{payment including } fb)_i = \sum_{j=1}^q (p_j \times t_{ij} + fb_{ij}) = \sum_{j=1}^q p_j \times t_{ij} + \sum_{j=1}^q fb_{ij} = (\text{payment without } fb)_i + \sum_{j=1}^q fb_{ij} \quad (3)$$

That is to say, the amount that a municipality would pay is the same amount that it would pay without the *feebate* system plus the addition of the fees and rebates corresponding to every treatment.

When there is only one kind of waste treatment or when the *feebate* system does not discriminate among different treatments ( $j=1$ ), the proposal is equivalent to defining a different price per tonne for each municipality, solely as a function of its per capita waste generation.

In some cases, waste treatment costs are not directly assumed by the municipalities integrating the association, but translated to the citizens in the form of taxes. In this case, one would simply have to divide the amount that each municipality would have to pay or receive in the form of fee or rebate ( $\sum_{j=1}^q fb_{ij}$ ) by the number of taxpayers and add the result to the tax, as a supplement or discount.

Due to the way fees and rebates have been defined, the proposed system is neutral for the association budget, in the sense that either with or without it the total contribution of the municipalities to the association would be the same. All fees and rebates add up to zero, globally canceling each other out:

$$\forall j \quad \sum_{i=1}^p fb_{ij} = 0 \quad (4)$$

because for any  $j$ :

$$\begin{aligned} \sum_{i=1}^p fb_{ij} &= \sum_{i=1}^p \left( n_j \times \left( \frac{t_{ij}}{\text{pop}_i} - \frac{\sum_{i=1}^p t_{ij}}{\sum_{i=1}^p \text{pop}_i} \right) \times \text{pop}_i \right) \\ &= n_j \times \left( \sum_{i=1}^p \left( \frac{t_{ij}}{\text{pop}_i} \times \text{pop}_i \right) - \sum_{i=1}^p \left( \frac{\sum_{i=1}^p t_{ij}}{\sum_{i=1}^p \text{pop}_i} \times \text{pop}_i \right) \right) \\ &= n_j \times \left( \sum_{i=1}^p t_{ij} - \frac{\sum_{i=1}^p t_{ij}}{\sum_{i=1}^p \text{pop}_i} \times \sum_{i=1}^p \text{pop}_i \right) \\ &= n_j \times \left( \sum_{i=1}^p t_{ij} - \sum_{i=1}^p t_{ij} \right) = 0 \end{aligned}$$

One could equally demonstrate that the amount paid by the municipalities to the association is globally the same with and without the implementation of the *feebate* system. Therefore, for the association as a whole the implementation of the proposal is economically neutral:

$$\begin{aligned} &\sum_{i=1}^p (\text{payment without } fb)_i \\ &= \sum_{i=1}^p \left( (\text{payment without } fb)_i + \sum_{j=1}^q fb_{ij} \right) \\ &= \sum_{i=1}^p (\text{payment without } fb)_i + \sum_{i=1}^p \sum_{j=1}^q fb_{ij} \\ &= \sum_{i=1}^p (\text{payment without } fb)_i \quad (5) \end{aligned}$$

The association only has to assume the administrative costs of managing the *feebate* system. Alternatively these costs can be charged to the municipalities as a flat rate.

#### 4. A numerical example

Below is a numerical example of the implementation of the proposal. The data used have not been extracted from a real case but all values are plausible.

Let us suppose that an association of three municipalities share two common facilities: a landfill with a cost of 4000 monetary units (m.u.) per treated tonne, and a recycling plant with a cost of 5000 m.u./t. It is assumed that no waste is produced at the recycling plant that needs to go to the landfill. The number of inhabitants, the annual and per capita waste generation, and the distribution of waste treatments are detailed in Table 1.

Using Eq. 1 the fees and rebates ( $fb_{ij}$ ) can be calculated, as a function of the  $n_j$  coefficients that have to be defined by the association, presumably different for each treatment  $j$ :

$$\begin{aligned} fb_{11} &= n_1 \times \left( \frac{t_{11}}{\text{pop}_1} - \frac{\sum_{i=1}^p t_{i1}}{\sum_{i=1}^p \text{pop}_i} \right) \times \text{pop}_1 \\ &= n_1 \times (0.60 - 0.405) \times 20,000 = 3,900 \times n_1 \end{aligned}$$

Analogously:

$$\begin{aligned} fb_{21} &= 1350 \times n_1 \\ fb_{31} &= -5250 \times n_1 \\ fb_{12} &= -700 \times n_2 \\ fb_{22} &= -2550 \times n_2 \\ fb_{32} &= 3250 \times n_2 \end{aligned}$$

As expected, for any value of  $n_1$  and  $n_2$  fees and rebates cancel each other for any treatment  $j$  (Eq. 4):

$$\begin{aligned} \text{for } j = 1: & \quad 3900 \times n_1 + 1350 \times n_1 - 5250 \times n_1 = 0 \\ \text{for } j = 2: & \quad -700 \times n_2 - 2550 \times n_2 + 3250 \times n_2 = 0 \end{aligned}$$

Table 1  
Number of inhabitants, annual and per capita waste generation, and distribution of waste treatments for each municipality

Municipality	Number of inhabitants	Annual waste generation (t)	% To landfill	% To recycling	t per capita to landfill	t per capita to recycling
Municipality 1 ( $i=1$ )	20,000	16,000	75.00	25.00	0.600	0.200
Municipality 2 ( $i=2$ )	30,000	18,000	75.00	25.00	0.450	0.150
Municipality 3 ( $i=3$ )	50,000	30,000	50.00	50.00	0.300	0.300
Total	100,000	64,000	63.28	36.72	0.405	0.235

After technical and political considerations, the  $n_j$  values for each treatment could be defined and  $fb_{ij}$  calculated. Let us suppose that, for example,  $n_1=20$  and  $n_2=-10$  were chosen by the association in order to promote recycling over landfill among the municipalities. The resulting fees and rebates are shown in Table 2.

Without the implementation of the *feebate* system the payment of a municipality to the association would be calculated using Eq. 2, whereas the payment by the municipalities with the implementation of the system would be calculated using Eq. 3. Results are shown in Table 3. Again, by summing all payments, the total obtained is the same as in the case where no *feebate* system was implemented (Eq. 5). Not only does this occur globally, but also for every different treatment (Eq. 4). On the contrary, municipalities are individually affected, as one can notice by comparing their payments with and without the implementation of the system (Table 3).

With adequately defined  $n_j$  values, those municipalities with a higher per capita waste generation would face penalization. In the example, municipalities 1 and 2 treat waste in the same way (Table 1), but the former has a higher per capita generation. With the implementation of the system, this would result in a higher payment by municipality 1 to the association. Additionally,

Table 2  
Fees and rebates for each municipality and treatment

$fb_{ij}$ (m.u.)	Landfill ( $j=1$ )	Recycling ( $j=2$ )
Municipality 1 ( $i=1$ )	$3,900 \times n_1 = 78,000$	$-700 \times n_2 = 7,000$
Municipality 2 ( $i=2$ )	$1,350 \times n_1 = 27,000$	$-2,550 \times n_2 = 25,500$
Municipality 3 ( $i=3$ )	$-5,250 \times n_1 = -105,000$	$3,250 \times n_2 = -32,500$

Table 3  
Annual payment by each municipality with and without the *feebate* system

Municipality	Annual payment without <i>feebate</i> system (m.u.)			Annual payment with <i>feebate</i> system (m.u.)			Change in total payment (%)
	Landfill ( $j=1$ )	Recycling ( $j=2$ )	Total	Landfill ( $j=1$ )	Recycling ( $j=2$ )	Total	
Municipality 1 ( $i=1$ )	1,200,000	320,000	1,520,000	1,278,000	327,000	1,605,000	-5.59
Municipality 2 ( $i=2$ )	1,350,000	360,000	1,710,000	1,377,000	385,500	1,762,500	+3.07
Municipality 3 ( $i=3$ )	1,500,000	1,200,000	2,700,000	1,395,000	1,167,500	2,562,500	-5.09
Total	4,050,000	1,880,000	5,930,000	4,050,000	1,880,000	5,930,000	0.00

municipalities managing wastes in a more ecological way would have compensatory rebates. In the example, municipalities 2 and 3 have the same overall per capita generation, but the later recycles a higher proportion of its waste (Table 1), resulting in a lower contribution per tonne to the association.

## 5. Conclusions

The implementation of the proposed *feebate* systems would sensibly foster municipalities to improve their waste management practices. However, their implementation may have some difficulties. In particular, some associations may require consensus to change the way they calculate the payment of each municipality for the use of the shared facilities. In this case, since the implementation of a *feebate* system will imply municipalities with worse waste management to pay more, it is likely to expect from them resistance or even veto. This will be more easily overcome if implementation is progressive, with low fees and rebates in the initial periods and subsequent steady increases. This smooth transition would facilitate the adaptation of municipalities with older collection schemes.

Another difficulty may arise in the definition of the  $n_j$  values. Because of their importance in the *feebate* system and because of their variation depending on local conditions, the calculation of these values should generally be addressed particularly by each association and this will imply important costs.

Moreover, the  $n_j$  values will not only be the result of a purely scientific process, but will be affected by political preferences and agendas. Therefore, they might be difficult to justify and that may pose a difficulty in

implementation. The selection of the  $n_j$  values is a topic for further research.

Further research should also focus on how the proposed *feebate* system could be adapted to deal with municipalities where high per capita waste generation or low recovery is not (only) caused by their poor environmental performance, but due to particular social characteristics (i.e. regions of tourism or towns with extensive commercial areas).

Other types of *feebate* systems could also be designed. One could, for example, define fees globally higher than rebates, so the difference could pay for the administrative costs of maintaining the system, or one could define *feebates* for each municipality as a function of the difference between their present results and the results obtained in the previous year.

The *feebate* system described here does not include any baseline entitlement in terms of the amount of waste that a municipality can generate or the amount that can be sent to a treatment facility before fees and rebates are calculated. The use of baseline entitlements would imply a different analysis to find the proper levels of *feebates*. Moreover, baseline entitlements are similar to permits, and therefore municipalities could be allowed to trade them. But that would require an entirely different analysis.

The effectiveness of *feebate* systems as described in this research would depend upon the intensity of fees and rebates in comparison to the costs that municipalities face to advance in source reduction and to collect and carry waste to the most ecological treatments. The effects of the implementation of a *feebate* system are difficult to predict accurately beforehand. More research is also needed to address the issue of predictability.

Environmental taxes, tradable permits and other environmental policy instruments based upon the “polluter pays” principle are currently being used with success (European Environment Agency, 1996, 2000). By making polluters economically responsible for their ecological practices, they are fostered to improve them.

That is also the basic guiding principle of *feebate* systems, therefore they are also expected to create incentives leading to environmental improvements.

In associations of municipalities sharing waste treatment facilities, the system presented in this paper could contribute to assign treatment costs in a more equitable way and to promote waste minimization and more environmentally friendly waste management among municipalities.

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