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## Working Group on Waste Prevention and Recycling

### Impacts of Unit-based Waste Collection Charges

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## **FOREWORD**

This report was prepared by Dominic Hogg of the consultancy firm Eunomia Research & Consulting Ltd., Bristol, United Kingdom. It has benefited from comments by Delegates to OECD's Working Group on Waste Prevention and Recycling.

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# IMPACTS OF UNIT-BASED WASTE COLLECTION CHARGES

## EXECUTIVE SUMMARY

This report explores the costs and benefits of systems for charging householders for waste. The study looks only at charges which vary with the amount and characteristics of the waste collected, referred to in the report as differential and variable rate, or DVR, charging systems. It is not concerned with taxes or charges levied on householders which do not vary according to how the waste collection services are used. The study uses a cost-benefit approach to attempt to draw out whether the balance of effects of such systems is positive or negative.

### Literature Review

A literature review regarding the costs and benefits of DVR charging schemes was undertaken which revealed the following key points:

1. The benefits of recycling and waste reduction need to be taken into account in the analysis (in some analyses, they are not);
2. The effects on illegal waste disposal are difficult to estimate;
3. The external costs of illegal waste disposal are not known;
4. The review suggests weight-based and pay-per-bag schemes appear to perform best while schemes for which the charge is based upon the volume of the container perform worst;
5. Under DVR schemes, the net costs, to householders, of managing waste actually decreases where waste treatment and disposal costs are higher. This is because the avoided costs of disposal, associated with recycling and waste reduction, increase as disposal costs rise; and
6. Schemes are likely to perform best where there is a comprehensive system in place for collection of segregated materials for recycling. The provision of more comprehensive recycling services is made more likely where producer responsibility schemes operate, and makes more financial sense where residual waste treatment and disposal costs are high.

### Case Studies

Three case studies were undertaken to attempt to understand the costs and benefits of DVR systems in some detail. The case studies considered changes in material flows, changes in the costs of service delivery, and external benefits. The total costs and benefits of the system were then aggregated. In each case a number of different scenarios were examined. The case studies were selected based on the need to study a variety of systems, and on the quality of information that was available for the study. Systems from Torelles de Llobregat, Spain, Landkreis Schweinfurt, Germany, and Ghent and Destelbergen, Belgium were examined.

A key conclusion is that in each of the cases the net social benefit was positive across most scenarios. Only where external costs of air pollutants were assumed to be low, and where avoided costs of treatment/disposal were assumed to be low also did the balance of costs and benefits result in a net cost associated with applying the DVR scheme. In the Torelles de Llobregat system net private costs varied from €11.58 per household to €9 per household and external benefits from €11 to €20 per household (excluding illegal disposal). In Landkreis Schweinfurt the net social benefits appear to be no less than €14 per household before accounting for illegal activity. Finally in Ghent and Destelbergen

net social costs are estimated to be in the order of €2 per household in the worst case scenario rising to a net social benefit of around €21-34 per household in the best case scenario.

### **Other Experience**

South Korea implemented compulsory nationwide DVR charging for household waste in 1995. The scheme has contributed to a reduction in waste arisings of 15% over the period and an increase in recycling from approximately 15% in 1994 to nearly 50% in 2004. Illegal disposal was found to be a problem following introduction in 1995 but an effective enforcement programme has reduced illegal disposal incidents to 13% of their 1995 levels.

Two Danish studies looked at the impacts of weight and volume based charging schemes by comparing municipalities where such schemes were in place with 'reference' areas. One study found that areas with weight based charging had 55% less residual waste and 45% more recycling than the reference areas, while the areas with volume based collections had 13% less residual waste and 36% more recycling than the reference areas. The second study looked at why arisings levels were lower in the DVR areas. The study suggested that illegal activity may account for some of this effect, thereby reducing possible benefits from charging schemes. However closer inspection of the study suggests that whilst some of the observations may be valid, it would not be wise to generalise the more equivocal stance concerning the benefits of DVR systems generally.

### **Relationship between Charging and other Waste Management Policies**

The study looked also at the potential relationship between charging and other policies for managing household waste, in particular, the relationship between charging and packaging recycling targets, and systems for managing biowastes.

In situations where producers fund (directly or indirectly) for the costs of packaging collection there is incentive for municipalities to ensure utilisation of the service of the service is maximised, since it reduces the use, and hence, the cost of providing services for residual waste collection and disposal. In this instance charging systems for residual waste will provide incentives for households to further reduce waste (with possible benefits for those companies who seek to reduce / make more recyclable the packaging used to deliver their products) and to recycle. In those situations where there is no direct funding of the recycling service by producers charging can assist in improving captures of material for which collection infrastructure is already in place, but arguably, charging schemes ought to be applied carefully if collection services are not convenient. In this instance, the onus remains upon the municipality to provide the collection service in the first place.

Where local authorities choose to collect biowastes, a key issue is how they deal with garden wastes. There are two extreme approaches which local authorities can take to garden waste. On the one hand, they can seek to restrict the delivery of garden waste into the collection system. At the other extreme, local authorities can seek to maximise the delivery of garden waste into the waste stream. This is often the case in those local authorities faced with targets for recycling and composting set in terms of a percentage of the overall weight of waste collected. Case studies suggest that where they are charged, the pricing of biowaste collections can have a significant effect on the quantities of biowaste collected through doorstep collections, and whether it is collected through kerbside systems or at container-parks. In particular, free door-to-door garden waste collections may lead to excessive deliveries of garden waste into the collection system since there is no incentive to compost at home. Consequently, it makes sense for DVR schemes to be designed so as to ensure that biowaste collections, where they include garden waste, are not entirely free of charge. Typically, they should be charged for, but at a lower marginal cost than for residual waste.

### **Practical Policy Implications**

#### ***Implications for Government***

The case for *allowing* (as opposed to *not allowing*) DVR schemes appears to be quite compelling. There are at least two good reasons from the policy perspective:

1. The first is that where residual waste disposal costs are high, the potential for schemes to reduce costs through improving recycling rates and reducing the quantity of waste collected can help to reduce costs for municipalities. By extension, because these are systems for charging, and hence, recovery of costs, the costs to households may also be reduced;
2. The second is that they may support other policy objectives. For example, producer responsibility schemes which seek to improve rates of recycling of materials collected from the household waste stream, can experience improved rates and efficiencies through the use of DVR charging.

For Governments, on balance, there is probably no need to *demand* that charging systems are introduced. The desirability of variable charging, as discussed above, will depend upon the service which the charging system functions within, and this will vary locally.

### *Implications for Local Authorities*

Where possible, municipalities should seek to design charging structures which achieve the best compromise between:

- Incentivising behaviour which minimises external costs; *and*
- Incentivising behaviour which reduces the financial costs of the waste management system (so that those who behave in the desired manner experience lower costs).

Charging systems should consider not simply 'volume', or 'weight' as the basis for charging, but, importantly for collection logistics, the frequency of collection, especially of residual waste. This is because collection costs depend significantly upon the frequency of set-out of materials by households.

Because the potential for making financial savings is related to the avoided costs of residual waste collection and its treatment / disposal, this potential will be diluted significantly where municipalities have entered into long-term, fixed-rate contracts for residual waste treatment and / or disposal which effectively make the marginal cost of treatment / disposal equal to zero.

Municipalities are likely to experience fewer negative side-effects of DVR schemes – illegal dumping, and increases in time spent, and fuel used, by households in transporting wastes for recycling – if the quality and convenience of provision of separate collection systems is made a priority (kerbside, bring and container-park). There are linkages, therefore, to mechanisms for ensuring the provision of such infrastructure, such as producer responsibility, as well as to mechanisms for making residual waste treatment and disposal more expensive through, for example, regulatory and fiscal measures, since these make the provision of high quality recycling services by municipalities itself more likely. These pre-conditions make the introduction of DVR charging schemes more likely to generate net benefits.

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## IMPACTS OF UNIT-BASED WASTE COLLECTION CHARGES

### 1. Introduction

1. In the *OECD Environmental Outlook*, municipal waste generation was identified as one of five 'red light' sources (*i.e.* needing to be addressed urgently) of pressure on the environment. The OECD projected that municipal waste generation in OECD countries would grow by 43 % between 1995 and 2020.

2. The way in which householders are charged for their waste collection and treatment / disposal services varies both within and between different countries. A brief glance at the situation reveals, however, that a large proportion of the population of OECD countries is confronted with a system of payment for waste services which does not reflect the quantity of material generated. This situation – where the marginal cost of services for waste collection, treatment and disposal is zero – evidently implies that there is no incentive for households to alter their behaviour so as to reduce waste generation.

3. This report investigates the impacts on household waste of unit-based waste collection charges through the application of cost-benefit analysis. The study focuses on *charges*. It is not the intention of this study to review local *taxes* used to support the funding of waste management services (and, frequently, other locally provided services too).<sup>1</sup> Furthermore, the study is concerned mainly with charges which *vary with the amount and characteristics* of the waste collected. Some schemes levy charges for household waste collection at a variable rate but they offer only one container for the household. As such, the charge does not *vary* with the type of waste collected.

4. Here the focus is on schemes where the charging scheme works both through the variable nature of the charge applied to a given collection route, and on the differential rates across the different collection routes (collection of dry recyclables, collection of compostable / digestible materials, collection of combustible waste, collection of residual waste, etc.) which constitute the service offered. In other words, from an economic perspective, we are interested in schemes where both own- and cross-price effects are important. Elsewhere, such schemes have been referred to as DVR (Differential-and-Variable-Rate) charging schemes and this term is used in the rest of this report too.<sup>2</sup>

5. It is not intended, in the report, to provide a comprehensive review of the literature on this subject.<sup>3</sup>

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1. For a review of EU approaches to charging systems, see Proietti (2000) and Eunomia (2003).

2. See Eunomia (2003).

3. The reader is referred to, for example, Eunomia (2003) for a study reviewing European analysis of European schemes; Miranda, Bauer and Aldy (1996), Miranda and LaPalme (1997) for a review of US Literature; and Skinner and Fullerton (1999) for an overview of literature which has sought to estimate elasticities of response for charging schemes, most of which has been conducted in the US. This list – which is not extensive – provides a useful overview of experience and findings in the literature, with references to other sources.

## 2. Literature review and lessons learned

6. Whilst there is a large and growing body of literature assessing one or other aspect of the performance of DVR charging systems, a rather small number of studies have addressed the costs and benefits of such systems. Some of the key insights from four studies are given below – a more detailed discussion of the studies is given in Annex 1:

1. An analysis of costs and benefits cannot ignore the benefits of recycling and of waste reduction. Regarding benefits, the study by Fullerton and Kinnaman looked only at the benefits associated with a reduced demand for refuse collection and disposal, and did not seek to understand the benefits associated with recycling and composting.<sup>4</sup> This study was the only one reviewed that suggested that the costs of the DVR scheme exceeded its benefits;
  2. Estimates of illegal waste disposal are difficult to make with accuracy. The results from the work of Fullerton and Kinnaman are effectively linked to the behaviour and survey responses from a very small number of households. Despite this (and the authors' own cautionary notes), this figure is quite widely cited in subsequent literature;
  3. The external costs of illegal disposal are not well known. None of the studies quoted a figure, and we are not aware of any study that has estimated the external costs of illegal disposal of waste. Dijkgraaf and Gradus estimated, from an analysis of other benefits and costs, what the external costs of illegal disposal would have to be in order for the net benefits of charging to be reduced to zero.<sup>5</sup> These were calculated to be in excess of €750 per tonne;
  4. The work of Dijkgraaf and Gradus also suggests that when different types of DVR scheme are assessed, the weight-based and pay-per-bag schemes appear to perform best whilst those based on volume only perform worst;
  5. The study by Eunomia highlights the fact that the net private costs associated with introducing DVR schemes decline as the cost of treating and disposing of residual waste increases.<sup>6</sup> This reflects the fact that the incentive effect of DVR schemes tends to reduce the quantity of collected waste;
  6. The Eunomia study also stressed the desirability of having in place schemes for segregated collection covering a wide range of materials and in which the collection scheme is as convenient as possible (preferably, door-to-door for most households) so that they are given maximum opportunity to respond positively to the incentive provided by the scheme;
  7. None of the studies sought to include some estimate of the costs of time spent by households in engaging in recycling.
7. These studies have informed the methodological approach adopted in this work.

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4. See Fullerton and Kinnaman (1996).

5. See Dijkgraaf and Gradus (2003).

6. See Eunomia (2003).

### 3. Methodology

#### 3.1 General

8. In the case studies, we sought to understand the costs and benefits of the DVR charging system itself. This is not always straightforward. In many cases where DVR charging systems are introduced, changes to the waste collection infrastructure are made at the same time. There are very good reasons why this might be the case, and they relate to, *inter alia*:

- The nature of the charging system one wishes to introduce (this may have implications for, for example, the receptacles used to contain waste. The choice of receptacle can itself influence the quantity of material collected by households, as well as the costs of the collection system);
- The degree to which one seeks to avoid dumping becoming a problem by making available free (or lower cost) collection of recyclable and compostable material;
- The degree to which one wishes to constrain overall arisings (this is especially important in respect of biowaste collections); and
- The degree to which one wishes to minimise problems of ‘waste leakage’, i.e. contamination of separately collected fractions, (see Annex 2) (by setting differential charges across the collected fractions).

9. Consequently, in some cases, a real issue for studies of charging systems is ‘*what would have happened with all other things equal, but without the charging system in place?*’ Indeed, to the extent that the rationale for changing collection systems may be intimately connected to the operation of a charging system, it may sometimes be the case that the question should not even be asked (because the two are so closely linked).

10. In the studies undertaken, the answer to this question is based either on:

- What was happening before the charging system was introduced (where the introduction of charging is accompanied by relatively little change in the collection system); or
- An estimate of what might have happened in its absence (where there is change in the collection system). Evidently, this is based on some conjecture.

11. This demands an understanding of:

1. Changes in material flows;
2. Consequent effects on service delivery costs (including private costs); and
3. Consequent effects on external costs and benefits.

12. From this total costs and benefits can be calculated. The basic concept is shown in Figure 1 below, and expanded in the following subsections.

#### 3.2 Changes in material flows

13. Mapping the flow of materials is essential to understand the nature of the external costs and benefits of the overall system. Hence, we have tried to understand (and where this has not been possible, to estimate):

### **3.3 *Changes in costs of service delivery.***

14. This includes the change in the private costs of treatment as well as collection. Hence, it accounts for:

1. Changes in cost associated with changes in the quantity of waste generated;
2. Changes in cost associated with the change in quantity sent for disposal;
3. Changes in cost associated with the change in the quantity of material collected for recycling / composting;
4. Changes in cost associated with increases in illegal dumping;
5. Associated changes in costs of enforcement;
6. Changes in cost associated with the introduction of the charging system itself, including changes to the vehicles, changes in the equipment used (tags, sacks, micro-chips, software, etc.), and the costs of administration (including billing); and
7. Changes in the time spent by householders in recycling / composting. In the case studies, we have incorporated these figures in the spirit of sensitivity analysis, partly because (as discussed above):
  - a) there are doubts about whether this cost should be included (and at what hourly rate for the time spent); and
  - b) it is extremely difficult to estimate any counterpart benefit of the nature which makes many households recycle even where there is no incentive to do so.

The discussion of this has, in general, been restricted this to the additional time spent making journeys to container-parks and bring sites where this appears to occur. Because no counterpart benefit can be estimated, the approach seems likely to overstate net costs of this additional activity.

15. This final issue is discussed in more detail in Annex 2.

### **3.4 *External costs and benefits***

16. The mapping of the flows of material is an interim step which enables an estimate of the net change in external costs and benefits to be made. This is based upon an estimate of the unit damage costs of the different treatment routes associated with the changes brought about by the DVR charging scheme.

17. It should be noted that the external costs of different waste treatment options vary in different circumstances and with the assumptions employed, and the same is true of the private costs. Some commentary on the nature of the variables is provided in Annex 3.

### **3.5 *Total costs and benefits***

18. The total costs and benefits of the system are then aggregated. Some of the issues where there is uncertainty have been highlighted, and the sensitivity of the results to different assumptions made in each of the case studies has been discussed. To highlight some of the uncertainties in an explicit manner, high and low estimates of the external costs have been used.

#### 4. Key results from case studies

19. This study undertook three case studies, based upon earlier work, which sought to understand the costs and benefits of specific scheme used in European countries. More detail is given in Annexes 4-6.

##### 4.1 *Torrelles de Llobregat, Spain*

20. This scheme – the first DVR charging scheme in Spain, and at the time of writing, still the only such experience – was implemented on 14 January 2003. Information was gathered from articles by Puig Ventosa,<sup>7</sup> supplemented by the author's analysis.

21. The DVR charging scheme for households consisted of the following:

- Biowaste was collected with no charge three times per week in compostable sacks within brown buckets of 25 litre capacity. The sacks and the buckets were provided by the municipality. A fourth collection was operated in the summer months;
- Paper and card were collected once per week at no charge. Materials were to be presented in such a way as not to create problems of litter on the streets;
- Glass was the only material which was still to be collected through a bring scheme (using igloos), also free of charge.

22. All other wastes (mainly packages and residual wastes) were left for collection inside special standardised plastic sacks provided by the Council. The cost of these sacks formed part of the waste charge paid by households, and they were distributed through local retailers. The sacks for residual waste were priced as follows:

- 40-litre bag: €0.60 each
- 100-litre sacks: €1.50 each (available for commercial enterprises).

23. The intention was to create an incentive for waste reduction and recycling. Apart from these fractions, the following fractions were also collected:

- Nappies (or diapers) within special opaque white sacks;
- Garden waste, other than large branches, placed in specific sacks on the same day as the collection of kitchen wastes; and
- Garden waste in the form of larger branches could be taken to the civic amenity site, or directly to the compost plant.

24. The sacks for the nappies and the garden waste had the logo of the municipality on them as well as the name of the waste fraction for which they were to be used. The garden waste sacks were biodegradable, and were charged at €0.40 per 50 litre sack.

##### *Key Results*

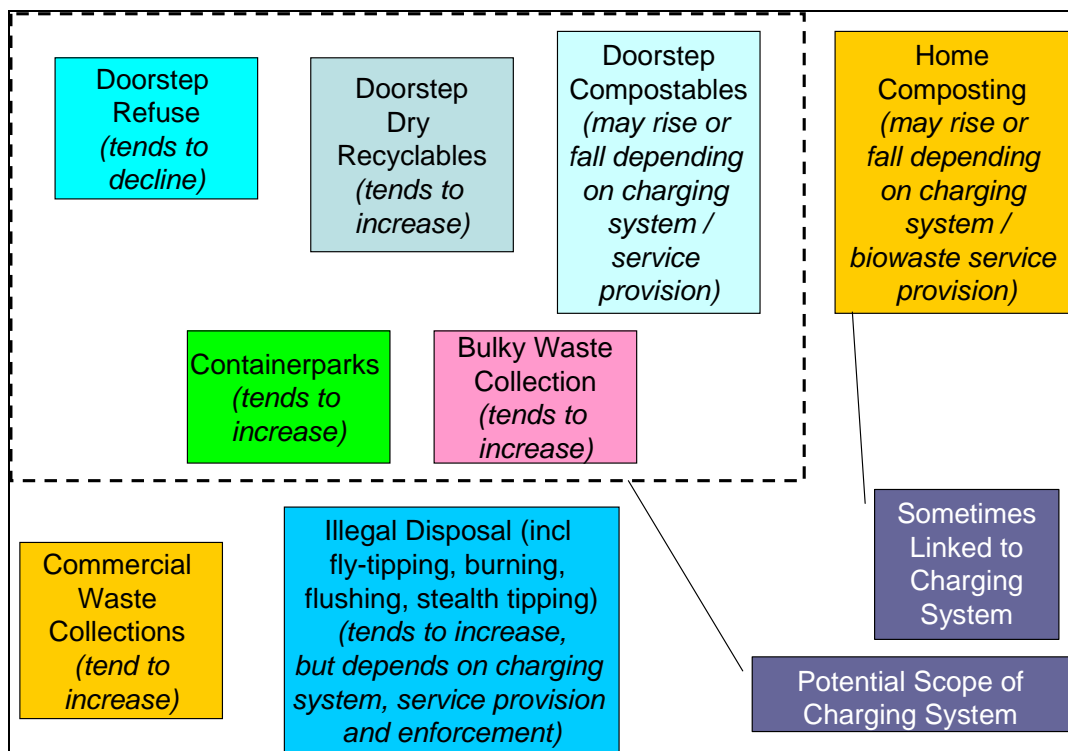
25. The most significant outcomes were a reduction in the quantity of collected residual waste by 38%, and an increase in separately collected materials from 33% to 89% including the bulky and

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7. See Puig Ventosa (2002) and (2003).

1. The change in the total quantity of material collected, and the ways in which this material was managed before and after the charging system was introduced (including estimates of illegal dumping, estimates of increases in home composting and estimates of genuine waste reduction);
2. The change in quantity of material sent for disposal and the disposal route which would otherwise be used;
3. The change in quantity of material sent for recycling, characterised by material (i.e. metals, paper, card, plastics, etc.)
4. The change in the quantity of material collected separately for subsequent biowaste treatment (composting or anaerobic digestion);
5. The changes in the collection route used (for example, to what extent does waste move from doorstep collection and into container-park collection?); and
6. The movement of waste across administrative categories. Several studies seeking to understand the reduction of waste as a result of charging systems do not mention the clear possibility that commercial waste which had been entering the municipal waste stream moves 'back where it belongs' once charging systems are introduced. What is known as 'stealth tipping' by small commercial operators no longer carries a zero marginal cost. This is obviously more likely to happen in municipalities which make a distinction between the municipal collection and the 'trade waste' collections. Identifying this shift is not straightforward, but it is important if one is to understand the actual environmental benefits associated with charging. To the extent that this occurs, it reduces any environmental benefits associated with what might otherwise appear to be 'avoided disposal' (the waste is still present, but collected for disposal as commercial, rather than municipal, waste).

**Figure 1. Concept of mass flows for understanding the effect of charging**

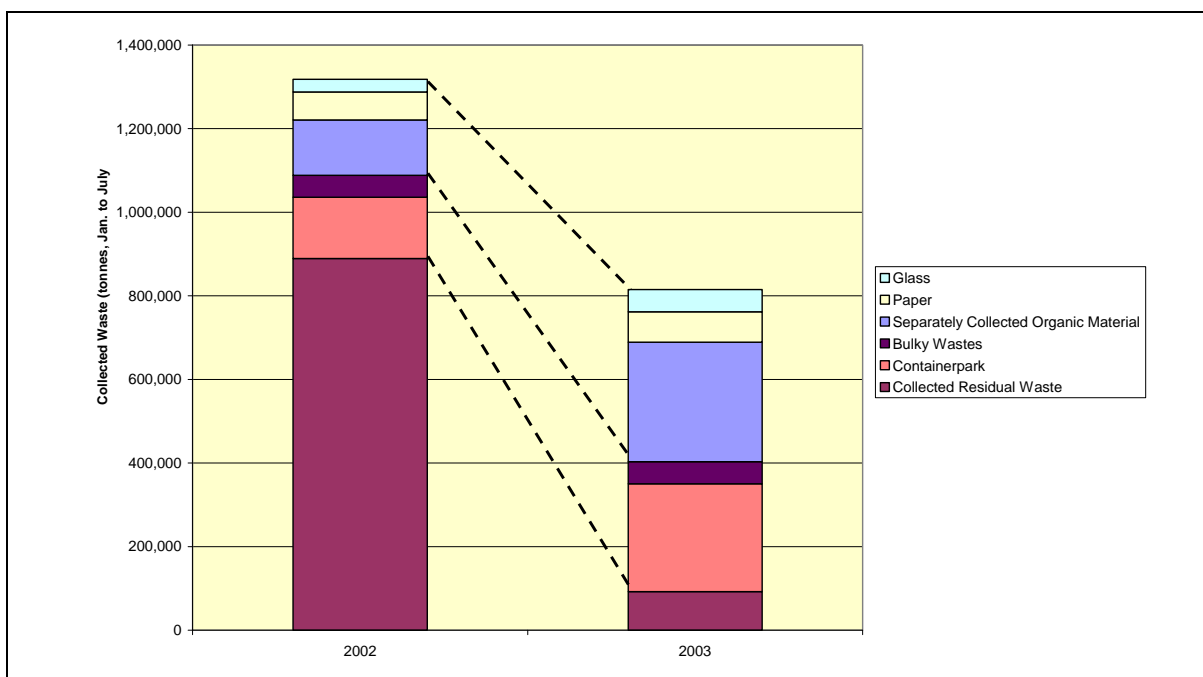


container-park fractions, or from 17% to 51% including only organic materials, paper and glass. Figure 2 illustrates the change in the collected fractions graphically.

26. The case suggests the following:

- Net private costs of €1.58 per household if the avoided disposal is landfill or -€ per household if the avoided disposal is a non-landfill treatment; and
- Net external benefits of between €1 and €20, depending upon whether high or low unit damage costs are used. This excludes external costs associated with illegal disposal. These fall (based on a range of assumptions) by around €-10 per household once one accounts for time spent by households in making greater use of the container-park.

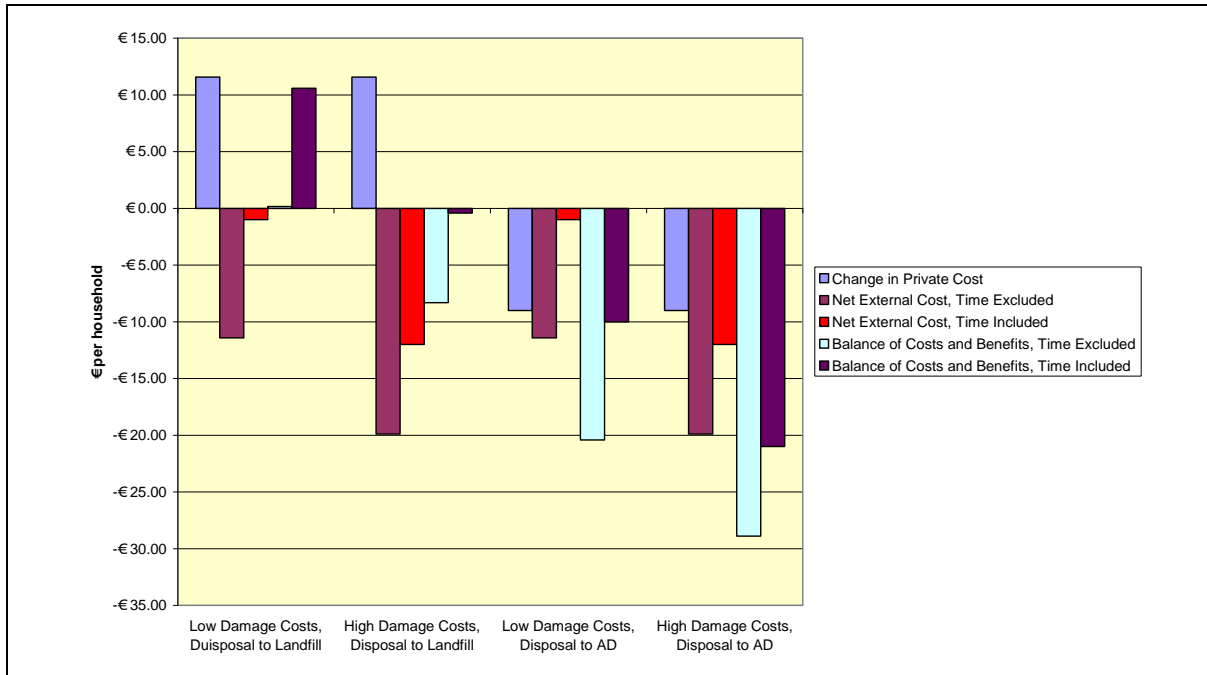
**Figure 2. Changes in collected quantities and quantities recycled, Torrelles de Llobregat**



27. The possible permutations for the balance of costs and benefits are shown in Figure 3. This shows that the balance of costs and benefits is positive (*i.e.* there is a net cost) only in the case where damage costs are low, and the avoided disposal route is lower cost landfill.

28. Even in the cases where the costs of time are considered, the balance of costs and benefits is negative (*i.e.*, there are net benefits). In the best scenario, the benefits exceed €20 per household.

29. It should be noted that these costs and benefits are not attributable solely to the charging scheme. They are attributable to a combination of a change in service and the introduction of the charging scheme. We have not tried to separate these out in this particular case, but perhaps the important thing is the fact that the combined scheme potentially delivers significant net social benefits, notably where the avoided form of disposal is not landfill.

**Figure 3. Balance of costs and benefits of DVR scheme, Torrelles de Llobregat**

Note: AD means 'anaerobic digestion'.

30. These costs and benefits do not account for:

- The potential disbenefits associated with illegal disposal (other than those concerned with its disposal); and
- Changes in associated transport externalities. These could be assumed to be broadly internalised in the private costs of transport.

31. On balance, therefore, whilst negative social costs are possible under the scheme, the scheme appears more likely to offer net benefits.

32. The assumptions made concerning the value of time spent in engaging in additional recycling activity are potentially important, and where the private costs of residual waste treatment are low, these could even be decisive in an analysis of costs and benefits.

33. Important issues which the scheme appears to have raised relate to movement of waste into other routes. This may be a particular problem in small jurisdictions where a charging system is applied with no other schemes operated nearby. Effectively, the perimeter of such an area relative to the total area is large. All households are likely to be close to the perimeter, and they may find it easy to move waste across administrative boundaries.

34. The increase in visitors to the container-park is also of interest. This can probably be explained best by reference to the fact that the scheme effectively charged on the basis of volume, and some of the low-density / high-volume materials such as plastic bottles and metal cans could not be recycled through the door-to-door collection service. Different schemes – notably, those with greater materials coverage – are likely to give rise to smaller numbers of additional movements. It is worth stating also that, to the extent that movement of materials onto the container-park is made more likely through charging schemes, any additional costs attributable to these movements are likely to be significantly lower where the density

of sites is high (so that journey distances / times are kept down), and where the sites are located in places which are close to areas which are frequently visited by citizens (so that the number of 'dedicated' journeys is minimised).

#### **4.2 Landkreis Schweinfurt, Germany**

35. The DVR charging scheme in Landkreis Schweinfurt was introduced as an amendment to an existing scheme in 1999. The charging system constitutes a three-part tariff:

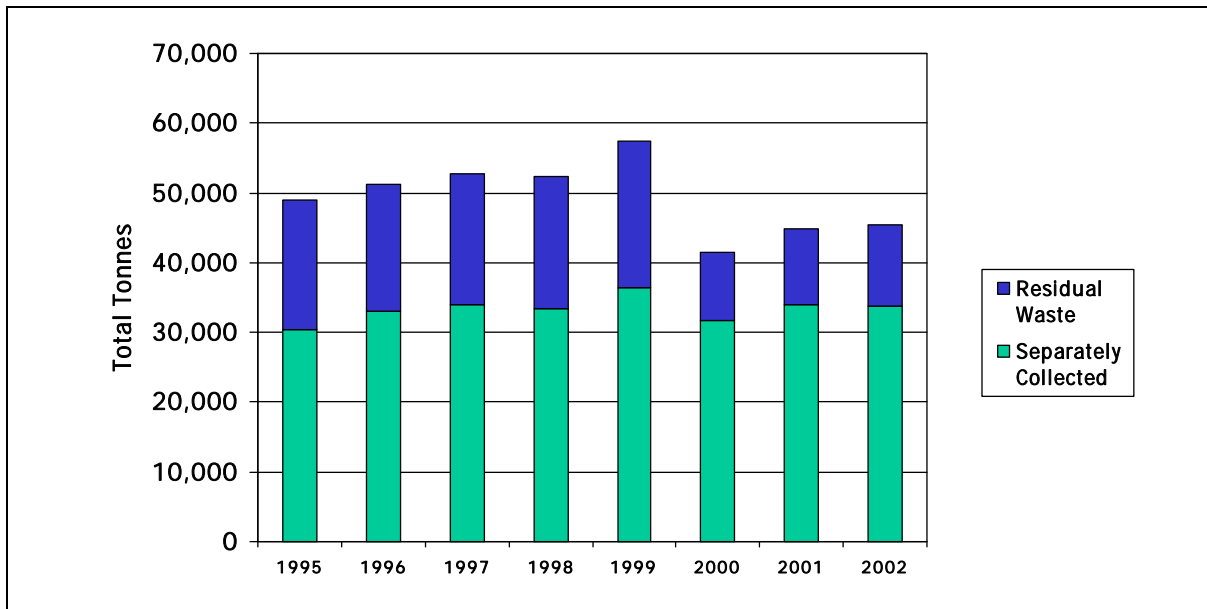
1. **A fixed annual fee.** This was intended to cover the fixed costs of the collection infrastructure, including the bulky waste collection, the collection of tyres, fridges, special wastes etc. This fixed element does vary with the size of residual waste bin chosen (the fixed fee is only linked to the refuse bin). For a 120l bin, in 2002, the fee was €3 per month, and for a 240l bin, the fee was €6 per month. The minimum bin size is 120l. It was felt that smaller bins are unlikely to lead to optimised collection of the different fractions.
2. **A fee per emptying of any bin.** The basis for the 'emptying charge' is the amount saved by not emptying a bin. This was calculated as €0.20 per emptying;
3. **A weight-based fee.** This was set at €0.25/kg for residual waste and €0.15/kg for biowaste in 2002.

36. The billing scheme works through an annual invoice, which calculates a bill based upon the previous year's performance by the household. At the end of each year, an adjustment is made to the preceding year's bill based upon the performance of the household relative to the beginning of year estimate. The bill is paid in 4 instalments.

#### *Key Results*

37. The net effect of these changes on the total system for waste management is shown in Figure 4. Between 1999 and 2000, total waste collected fell by 28%. However, this includes the expectations-related effects (in which 'clean-outs' occurred prior to scheme introduction). Taking this into account, the reduction was from 52,000 tonnes or so to 45,000 tonnes, a reduction of 13%.

Figure 4. Net effect on waste management system, Landkreis Schweinfurt



Source: Landratsamt Schweinfurt

38. Residual waste fell from a pre-scheme average of 165kg to a post-scheme average of 92kg per inhabitant, a reduction of 46%. The pre- and post-scheme average recycling rates shifted from 64% to 76%.

39. As regards 'leakage', the municipality states that the issue of contamination has not arisen. Biowaste collections are still above 95% purity. The officers of the municipality also state that the wastage rates from packaging collections are no different from other systems and from the pre-scheme situation.

40. This scheme gave rise to a reduction in costs of the order €6 per household. This includes the costs of monitoring and enforcement of fly-tipping, of which there has been some increase. The costs to the municipality do not include the costs of collecting packaging materials since these are borne by the DSD system. However, in this case, the packaging collections have not increased significantly other than at bring sites which are the least expensive service for contractors to run. Consequently, the costs of provision of this service probably changed relatively little as a consequence of the scheme.

41. The benefits are potentially considerable, and probably no less than €8 per tonne. The net social benefits, therefore, appear to be no less than €14 per household before accounting for illegal activity.

42. No estimate of additional time for sorting waste for recycling has been included. In this particular case, the principal increase in the quantity of material being recycled relates to the paper fraction. This does not require additional washing and the dense network of bring sites makes it far less likely that households make significant additional journeys to take materials for recycling.

43. In this particular case, the municipality has made considerable effort to understand the exact nature of the waste reduction, including the extent of illegal dumping. Our view is that illegal dumping is unlikely to be the source of the reduction and that other factors – efforts in waste reduction and re-use, changes in consumption patterns, and, possibly, a move of commercial waste away from the municipal stream – are likely to have been important.

### 4.3 Ghent and Destelbergen, Belgium

44. The DVR charging system in Ghent and Destelbergen commenced in 1998. For the purpose of the provision of waste services, Ghent and Destelbergen are divided into three areas, the central area, apartment buildings and the rural areas. Table 1 below shows the different charges applied for bins and sacks in rural and urban areas, respectively.

45. The residents in the centre of Ghent buy the relevant waste sack from one of the 350 distribution centres (shops, etc.). Waste sacks, packed in rolls of 10 or 25, are purchased at a fixed rate (no discounts are granted). The storekeeper receives a small fraction of the sales price (1 to 2 %). The service he/she is offering will enable the storekeeper to attract people who will buy other goods as well.

**Table 1. Structure of charging system applied in Ghent**

Type of waste	Recipient	Volume	Price in €
Refuse waste	Sack	15 l	€0.37 per sack
		30 l	€0.62 per sack
		60 l	€1.24 per sack
	Waste bin	40 l	€0.87 per pickup
		60 l	€1.24 per pickup
120 l		€2.48 per pickup	
240 l		€4.96 per pickup	
Biowaste	Biodegradable Sack	15 l	€0.25 per sack
		30 l	€0.50 per sack
	Waste bin	40 l	€0.62 per pickup
		60 l	€0.99 per pickup
		120 l	€1.98 per pickup
		240 l	€3.97 per pickup
Non-glass packaging (PMD)	Blue sack	60 l	€0.12 per sack
Paper/cardboard	-	-	No charge
Glass	-	-	No charge

Note: Where bins are concerned, the price is 'per emptying' of the bin. Residents choose the frequency with which they 'set out' their bin for collection. Each pick up is registered on the intelligent chip.

46. The residents in the rural area are obliged to use bins and pay in advance in accordance with the size of the container for 18 'emptyings'. Waste bins, one for residual waste and one for 'meat-excluded' organic waste (i.e. kitchen and garden waste), are supplied free of charge to each resident in the rural area of Ghent. The bin has a unique intelliGhent chip which registers each individual emptying of the bin. It is automatically read by a reading device mounted, at the back, on the loading system of the truck.

47. Of the total costs for collection and processing / treatment / disposal, approximately 20% are met by the charges paid for sacks and emptyings of bins.

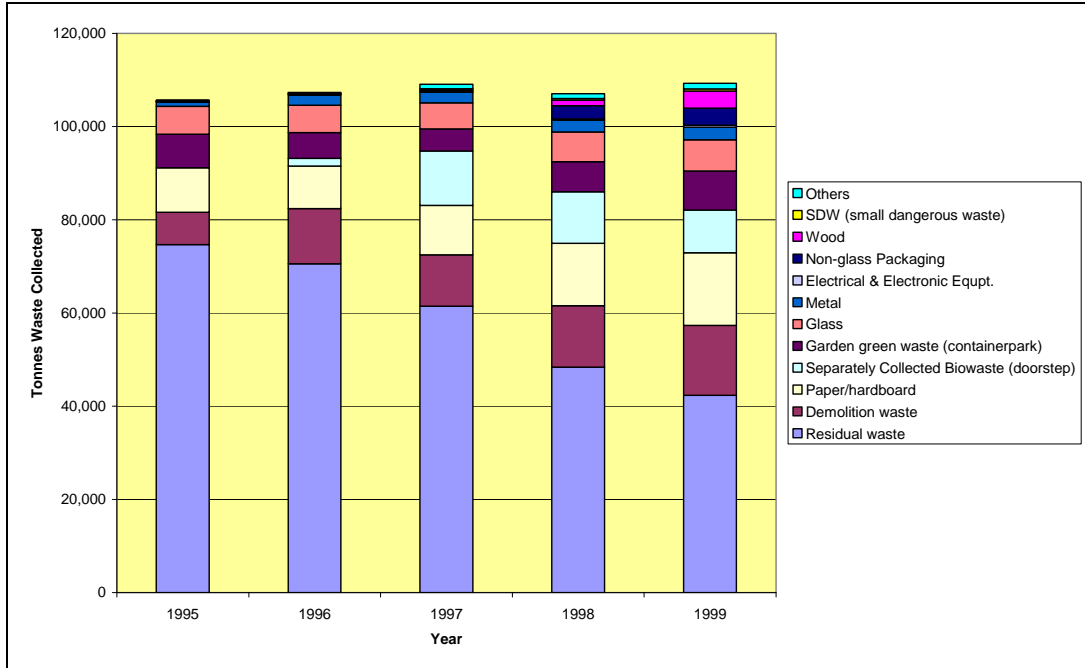
#### Key Results

48. If one compares the period before 1998 and the period after, one sees a continuation of the improvements made in separate collection (see Figure 5), a continuous increase in waste delivered to bring sites, and – in the year 1998 – a slight constraint on overall growth of waste arisings (though this is barely discernible, and could not be assumed to be statistically significant) (again, see Figure 5).

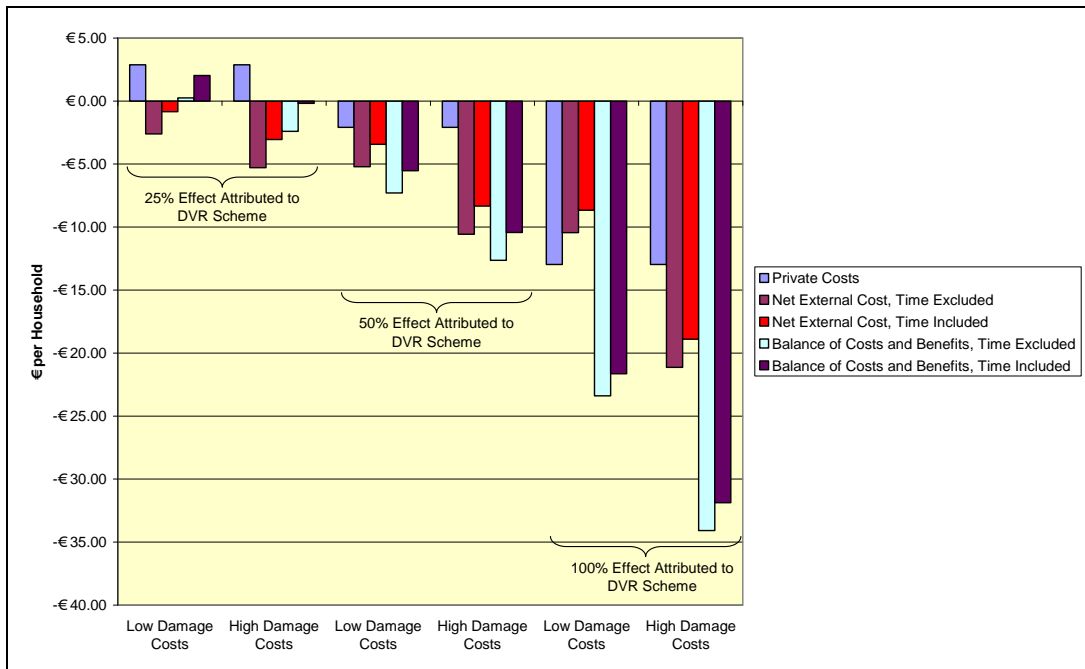
49. The potential permutations of costs and benefits are shown in Figure 6 below. Because the scheme was introduced at the same time in a period where other changes were being made, these are shown for cases where 25%, 50% and 100% of the effects of the DVR scheme and the enhanced service are attributed to the DVR scheme. The net costs clearly depend upon the attribution. Attributing all the

change to the charging scheme seems unrealistic and would lead to benefits (cost reductions) far greater than in the other schemes examined even though the effect on waste prevention is barely existent in this case. Even where only 25% of the effects of the change from 1997 to 1999 are attributed to the scheme, however, net social benefits (cost reductions) lie between €3 and €5 per household.

**Figure 5. Evolution of system performance in IVAGO area**



**Figure 6. Balance of costs and benefits of DVR scheme, Ghent**



50. As with the case of Torelles de Llobregat, there are few permutations where the system imposes net social costs. These are where a) a relatively small effect is attributed to the DVR scheme, and b) where the damage costs used are low (so benefits of avoided disposal and recycling are smaller). Again as in the Torelles de Llobregat, the situation appears slightly worse where the costs of time are taken into account. However, in the case of Ghent, including these has a smaller effect, and even in the worst case, the net social costs are of the order €2.00 per household.

51. If, on the other hand, the DVR scheme is attributed with a more significant proportion of the change occurring between 1997 and 1999, then benefits may be as high as around €10 per household (50% effect attributable) rising to €11-34 if all the change occurring in the period is attributed to the DVR scheme.

52. On balance, therefore, and based upon the effects of DVR schemes in similar situations elsewhere, it seems likely that the DVR charging scheme will have contributed to the generation of net social benefits. Indeed, perhaps the more important observation is that, *as part of a package*, the DVR scheme contributed (however significantly) to the generation of net social benefits of the order €20-30 per household.

## **5. Experience from other jurisdictions**

53. This Section provides some information on experience with DVR schemes in Korea. Annex 7 and Annex 8 provide more detailed information, as well as information from other countries with charging schemes.

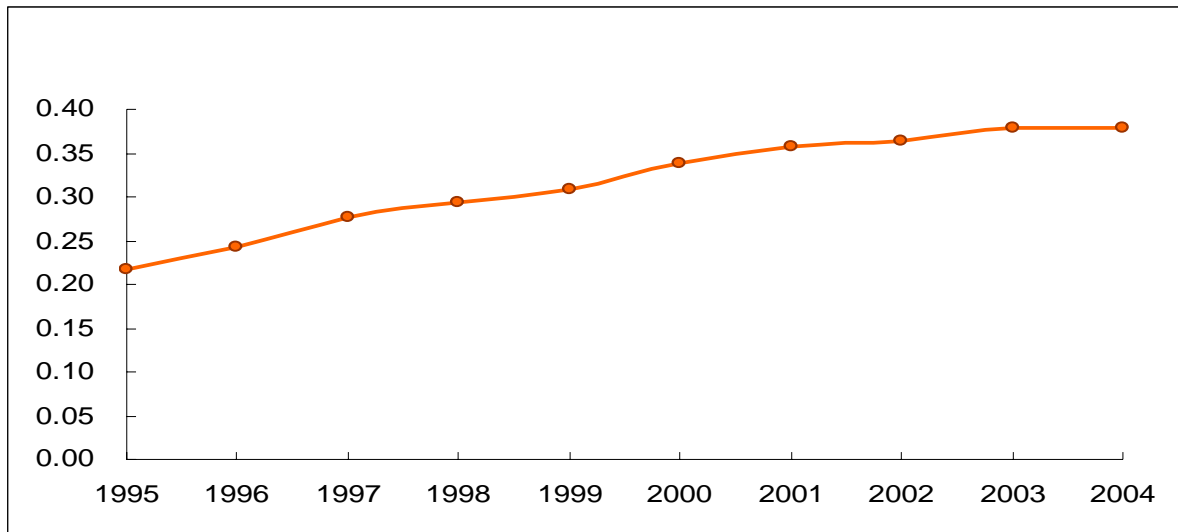
### **5.1 Korea**

54. Korea became the first country to introduce a DVR scheme country wide when, in 1995, the volume-based waste fee (VBWF) was introduced. The VBWF is essentially a pay-per-sack scheme under which households are required to place residual waste in pre-paid sacks whilst recyclables are collected free of charge. Charges are also levied on the collection of bulky wastes.

55. In recent years, the country has introduced free food waste collections for households, having commenced collections for larger producers of food waste (such as restaurants) in 1997. In 2005, the landfilling of kitchen waste from households was banned.

56. Different municipalities levy different charges for their bags under the VBWF scheme. Average prices for 20 litre bags have increased, however, as municipalities have sought to maintain or increase the share of total service costs covered by VBWF revenues. Evidently, if such schemes improve recycling performance and reduce waste sent for disposal, the revenue base declines, even though the total costs of service provision may not decline, and may even increase. The general increase in the average price for a 20 litre bag is shown in Figure 6.

**Figure 7. Prices for 20 litre volume-based waste fee sacks, Korea**  
1995-2004

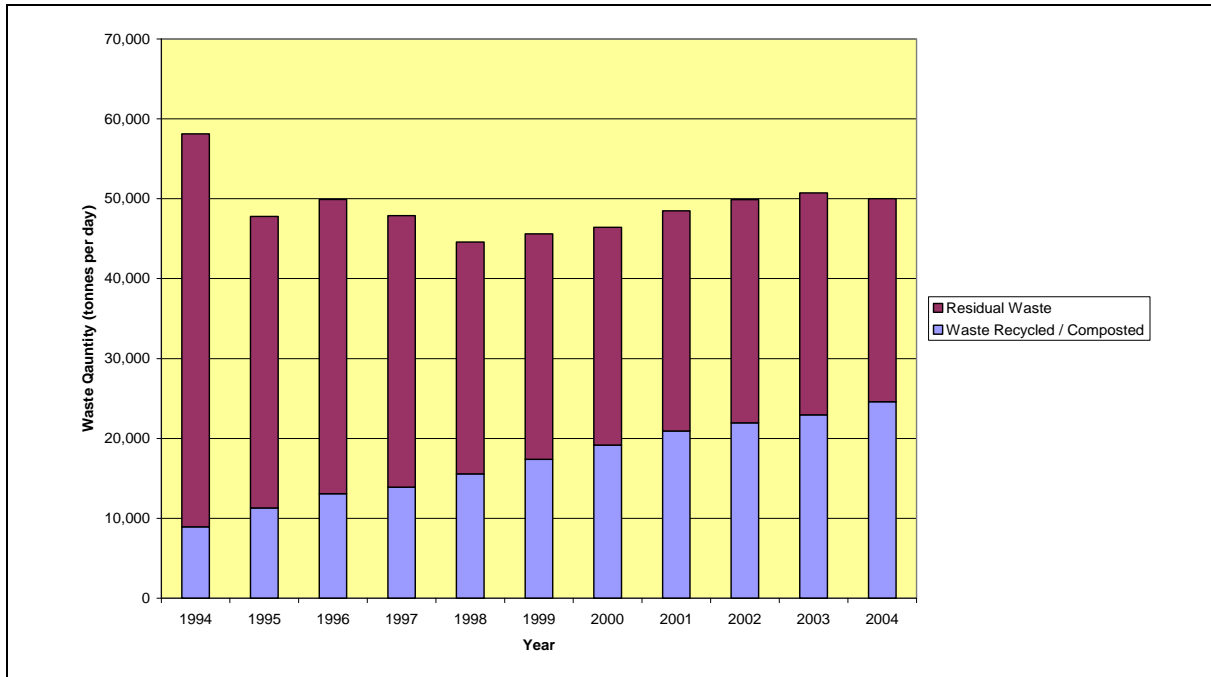


Source: Korea Environmental Policy Bulletin, Update Version of Issue 1, Volume 1, January 2006. Average fee per 20 litre sack.

57. The headline results have been impressive. As shown in Figure 8, total waste amounts have declined somewhat, the amount of residual waste has declined significantly, while the amount of waste recycled or composted has more than doubled between 1994 and 2004. No attempt to estimate costs and benefits of the scheme have been made here.

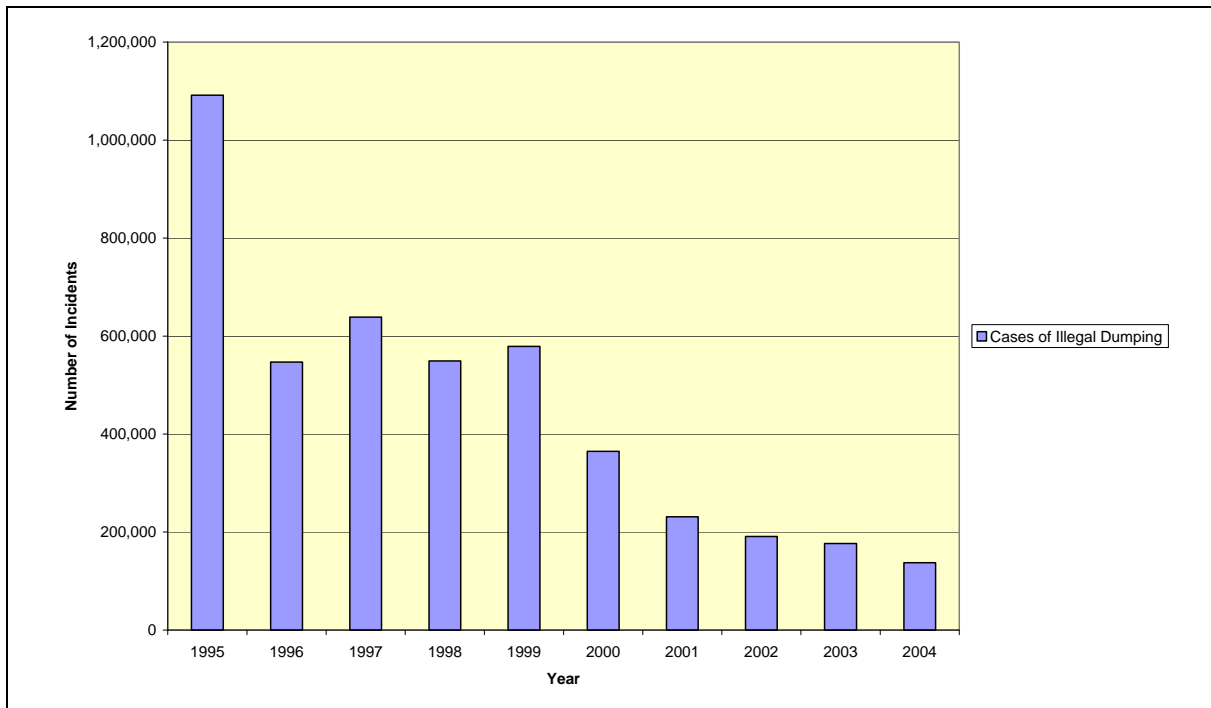
58. Implementation of the VBWF has not been without problems. Illegal disposal was a problem, though measures have been introduced to control this, including a system of fines which effectively encourages citizens to report people disposing of their waste illegally. Figure 9 shows how illegal dumping has declined over time. No information was obtained for the pre-scheme situation, but following the scheme's introduction, there has been a steady decline in incidents. Of the 75,631 incidents reported in 2004, more than half resulted in fines for the perpetrators. Overall, however, the scheme is considered a success by the authorities.

**Figure 8. Effects of volume-based waste fee in Korea**



Source: Korea Environmental Policy Bulletin, Update Version of Issue 1, Volume 1, January 2006.

**Figure 9. Illegal dumping incidents since volume-based waste fee was introduced in Korea**



Source: Korea Environmental Policy Bulletin, Update Version of Issue 1, Volume 1, January 2006.

## 5.2 Denmark

59. Two studies of significance have been carried out by the Danish EPA that have sought to shed light upon the impact of weight-based charging systems in Denmark.

60. The first study looked at 5 municipalities that had introduced weight-based collection schemes and compared these to 5 municipalities without weight-based schemes.<sup>8</sup> Two different approaches, one based upon comparative data analysis and the other based upon a questionnaire, were used.

61. The annual amount of domestic waste collected in the two local authority areas with volume-based waste collection schemes averaged 71 kg less per household than in the two reference areas. The capture rate for both paper and glass was more or less the same in the two local authority areas with volume-based waste collection schemes, whilst it was quite different in the two reference areas.

62. In local authority areas with weight-based schemes, the amount of domestic waste collected annually from each household averaged 359 kg less than in the reference areas. The difference drops to 279 kg per household a year when allowance is made for there being a higher level of home composting in local authority areas with weight-based schemes than in reference areas. Table 2 shows the collected amounts of residual waste, paper and glass as well as the collection efficiency rate for paper and glass.

**Table 2. Collected amount of waste and collection efficiency rates for paper and glass**  
Calculated in kg per household in 1999

Local authority area	Residual waste	Paper and cardboard	Glass	Total	Capture Rate (%)	
					Paper and cardboard	Glass
<b>Areas with weight-based collection schemes</b>	325	108	38	471	71	87
<b>Reference areas</b>	729	67	34	830	41	77
<b>Areas with volume-based collection schemes</b>	552	104	40	696	61	89
<b>Reference areas</b>	660	76	30	766	44	67
<b>Areas granting a reduction for home composting</b>	573	63	28	664	46	63
<b>Reference areas</b>	533	86	38	657	64	86

The collection efficiency rates have been calculated on the basis of potentials that are individual for the local authority areas in respect of paper, while the potential is the same for all areas in respect of glass.

63. The study did not reveal any differences in the consumption habits of the citizens of municipalities with and without weight-based schemes, and it was assumed that the same amount of waste is generated on average by households in the different municipalities. The difference in the waste amounts was assumed to be explicable only through reference to things *other than* different consumption habits.

64. The following reasons were offered for the difference in the registered waste amount:

- Waste may be delivered at recycling stations;
- Composting in private gardens may be higher than estimated in the study;
- Waste may be burned in private fireplaces/stoves or oil containers; and/or
- Waste may be dumped at lay-bys or parking lots.

65. The study led, therefore, to further questions being asked concerning the effects of weight-based schemes in Denmark. The second report incorporated information from three sub-studies carried out in the

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8. Danish Environmental Protection Agency (2000).

municipalities of Tinglev and Nørre Rangstrup. The aim was basically to shed more light upon the issue of the fate of waste which the above study suggested appeared to ‘disappear’ in the case of weight-based schemes. Analysis was undertaken of residual waste and the composition of waste collected in container-parks in the category ‘combustible waste’ as well as analysis of quantities of waste collected at lay-bys and service areas.

66. The report purported to highlight a higher level of illegal behaviour in the municipality – Tinglev – with weight-based charging in place. On this basis, it was more equivocal about the possible benefits of weight-based charging in Denmark. It is important to re-iterate that this was a comparative study of two municipalities only. Closer inspection reveals that the systems under investigation did not have comprehensive kerbside systems in place. Furthermore, one of the negative aspects of the scheme was taken to be the deposit of household residual waste in container-park skips designated for ‘combustible waste’. It is not clear that this would especially be problematic if the household residual waste was destined for combustion anyway. In any case, if this were a genuine problem, it suggests an easy remedy through proper supervision at the container-park.

67. Finally, the comparative analysis was based upon the premise that those in, and those outside the weight-based schemes would produce exactly the same quantity of waste. This is a) unlikely (based upon experience across municipalities in any given country); b) difficult to substantiate; and b) in direct contradiction to the overwhelming majority of the evidence. To the extent that this premise guides the otherwise laudable attempt to discover the fate of waste generated, it is likely to overstate the extent of ‘evasive behaviour’ and understate the potential for genuine waste reduction. The latter seems a possibility which the premise appears to deny.

## **6. Relationship between charging and other waste management policies and objectives**

68. The study looked also at the potential relationship between charging and other policies for managing household waste, in particular, the relationship between charging and:

- packaging recycling targets; and
- systems for managing biowastes.

69. Key points are made below. More detail can be found in Annex 9.

### **6.1 Packaging recycling targets**

70. The study considered two possible extremes. The first assumed a direct financial link between local authorities and producers. This was deemed to provide local authorities with the incentive to collect packaging materials, or alternatively, the service was delivered within the local authority area at zero cost. At the other extreme, where local authorities receive no direct budgetary support, there is no particular reason why they should provide additional services to those they would provide anyway to local residents.

71. If recycling systems are effectively zero cost to the authority, the local authority will have to cover the costs of the collection and treatment / disposal of residual waste, as well as the costs of biowaste collection and treatment. For this reason, the local authority is likely to seek to ensure that:

- households who *can* recycle *do* recycle (they have an incentive to use the recycling service);
- households who are provided with a biowaste collection make use of it (without disincentivising home composting – see below); and
- the costs of collection and disposal of refuse fall, as far as possible, upon those who generate most refuse.

72. This is where charging systems have a role to play. The combination of:

- Levies paid by producers to cover collection costs; and
- Charging systems reflecting the private and external costs of treatment / disposal

can help to ensure that householders are confronted with incentives to recycle, as well as incentives to reduce waste at the margin.

73. In those situations where there is no direct funding of the recycling service by producers, whether or not to provide the service, and in what form, is effectively left up to the municipality. In this situation, charging can assist in improving captures of material for which collection infrastructure is in place. At the same time, a municipality needs to consider whether DVR charging systems are appropriate where convenient kerbside collections are not in place. Arguably, the introduction of DVR schemes makes most sense where convenient kerbside collections are in place since this will minimise the temptation to dispose of waste illegally, and improve the capture of the targeted materials. If the scheme is funded by the local authority, however, consideration needs to be given to the recovery of revenues to fund the provision of the recycling service.

## **6.2 Management of biowastes**

74. The household biowaste fraction is one of the fractions which has to be considered most carefully where municipal waste management systems are concerned. The dynamics of the interaction between different components of the system, and some components which either are, or appear to be, outside it, have to be considered especially carefully.

75. Where local authorities choose to collect biowastes, a key issue is how they deal with garden wastes. In general, the more convenient is the collection of garden waste, then the more garden waste will be delivered into the collection system and the less will be processed at home (through home composting).

76. Where garden wastes are concerned, there are two extreme approaches which local authorities can take to garden waste. On the one hand, they can seek to restrict the delivery of garden waste into the collection system through one or more of the following:

- Restricting the size of biowaste containers;
- Seeking to restrict the delivery of garden waste into refuse;
- Seeking to restrict 'side waste' (the delivery of waste with a volume in excess of a container provided to the household);
- Charging for biowaste collections; and
- Promoting home composting.

77. At the other extreme, local authorities can seek to maximise the delivery of garden waste into the waste stream. This is often the case in those local authorities faced with targets for recycling and composting.<sup>9</sup> They can do this by:

- Offering large containers for separately collected waste;
- Not charging for the biowaste container (and charging for the residual);<sup>10</sup> and
- Not promoting home composting (or doing so only loosely).

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9. In Italy, a phrase used to describe this is, 'raccolta droggata' (which roughly translated means 'collection junkie'). The reasons are made more clear in the discussion in Annex 9.

10. This is the situation where the phenomenon of 'waste leakage' is most likely.

78. The difference in approach is often instantly recognisable. In suburban and rural authorities where garden waste collections are maximised, the total amount of waste collected at the kerbside is frequently around 200 kg per household greater per year than in those authorities where free garden waste collections are not in place. Some of this is usually associated with material which might otherwise have been delivered to container-parks / civic amenity sites. However, a significant proportion of this is usually 'new material', reflecting to some extent the fact that some households 'give up' home composting, and also, the fact that when a free garden waste collection is on offer, people tidy their gardens more than they otherwise would.<sup>11</sup> This has cost implications and, as long as home composting is carried out well, little environmental gain (indeed, probably an environmental disbenefit) results from the movement of materials from the garden into the formal collection and treatment system.

79. Once garden waste collections are in place, it is not straightforward to 'take them away', partly because they tend to be well-, if not over-, utilised. In these circumstances, the question becomes one of how to constrain costs through constraining delivery of garden waste into the collection system. Charging is one potentially effective route for doing this.

80. The Schweinfurt case study provides some instructive experience of this nature, as does (to a lesser degree) the experience in Ghent. In both cases, the charging schemes include a charge for the biowaste fraction. In both cases, there is considerable sensitivity to the issue of the relationship between the charge for biowaste collection and the charge for refuse collection.

81. For example, in the Schweinfurt scheme, if the charges for refuse collection and biowaste collection had been set in line with the treatment costs for each, the cost differentials would have been very high. The Council was concerned that this would simply lead to contamination of the biowaste container. Hence, the rate for the biowaste container was increased to reflect this concern.

82. In Ghent, the differential between the cost of refuse and biowaste collection are seen as a key issue in, on the one hand, incentivising separate collection and, at the same time, giving some incentive to home compost (to constrain collection).

83. In both cases, the impact on the biowaste has been significant. In Schweinfurt, the charging system has led to a significant reduction in the quantity of biowaste collected and this has been attributed to increases in home composting. In Ghent, the amount collected separately has actually increased, but the quantity collected separately (at kerbside) has dropped, whilst the quantity collected at the container-parks has increased.

84. This suggests that pricing the biowaste container can have a significant effect on the way biowaste, and in particular, garden waste, is collected. However, whilst there is much in the literature that purports to define own- and cross-price elasticities of demand for refuse services, knowledge concerning the magnitude of, and factors conditioning, price responsiveness of garden waste collections is quite limited.

## **7. Practical policy implications**

### **7.1 *Observations from the analysis***

85. One of the most clear conclusions one draws from both the more positive and the more negative experiences with variable charging is that it makes no sense to speak of variable charging being 'good' or 'bad' independently of an understanding of the context in which the charging system functions. Waste management systems are not simple, and they involve behavioural interactions between citizens, and a

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11. For example, see some of the analysis in Eunomia (2004). See also Favoino *et al.* (2003).

system which is, itself, a complex mix of logistics and treatment facilities. Waste managers face a vast array of choices in designing their systems, and even where they themselves make choices which would appear to be based upon sound analysis, the quality of service provision can frustrate attempts to provide services which residents can engage with in a positive manner.

86. The analysis of costs and benefits of specific schemes highlights some of the issues of significance in seeking to understand the balance of costs and benefits of charging schemes. Issues raised include the following:

- Still, the question as to how much waste is illegally dumped, and what the social costs of that dumping are, remains something of a mystery. Furthermore, there are few (if any) studies which have sought to estimate the social costs of dumping itself. In many situations, municipalities are themselves responsible for clean-up of fly-tipped waste. Because of this, waste managers may already be internalising the private costs of clean-up within the municipal budget. However, this still leaves the question of the external costs unanswered. Arguably, if the municipality is efficient in the clean-up process, the impacts of fly-tipped waste, both in terms of their impact upon disamenity and on the environment more generally, are likely to be reduced. In our experience, there is an elevated level of awareness shown by municipalities as to the potential for fly-tipping to follow from the implementation of charging schemes. This can be (and has been) a weapon against fly-tipping emerging as a problem since it leads to municipalities being forearmed with tools to ensure such activity does not persist. Such measures effectively make it far more likely that the long-run effects of charging on dumping are rather less than the short-term ones, as Fullerton and Raub suggest they might be.<sup>12</sup> None of this is necessarily comforting to those private land-owners who, in some jurisdictions, are the victims of fly-tipping, and are asked to bear the cost of clean-up themselves. In such cases, the municipality's costs are clearly externalised to citizens;
- The fact that waste 'moves' across administrative boundaries, and between different collection routes, has implications for social costs and benefits. Waste movement of both types has received relatively little attention as compared to illegal dumping. A hypothesis from this work is that movement of commercial wastes out of the municipal system is no less significant than illegal dumping in explaining 'where the waste went' following the implementation of variable charging. This is an important observation. Several attempts to understand 'what has happened to the waste' where charging has led to 'waste reduction' have assumed that the same materials should be being produced by those covered by the collection systems before and after the introduction of variable charging. This will not be true if before charging systems are introduced, some commercial wastes are entering the collection system. Some of these wastes are likely to move back to the commercial waste collection system once the marginal costs of collection for household waste are no longer zero. Consequently, some of the reduction in waste quantities may well be due not to changes in *household* behaviour, but to changes in the behaviour of operators of small commercial enterprises;
- The movement of waste across boundaries is an issue which was clearly of some significance in Torrelles de Llobregat. Because the ratio of a municipality's border to its area increases as its size falls, this would seem likely to be an issue of greater significance in situations where small municipalities implement charging schemes whilst contiguous areas have no such scheme in place. This will be made all the more likely if container-parks in the neighbouring areas accept all forms of waste at zero marginal cost. Arguably, therefore, charging systems will have fewer consequences for other authorities where they are being implemented more widely, and where the marginal cost of disposal is similar across neighbouring authorities. This supports the

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12. See Fullerton and Raub (2003).

approach of Italy, for example, in issuing guidelines as to what parts of the overall tariff for waste should be covered by fixed and variable rate fees;

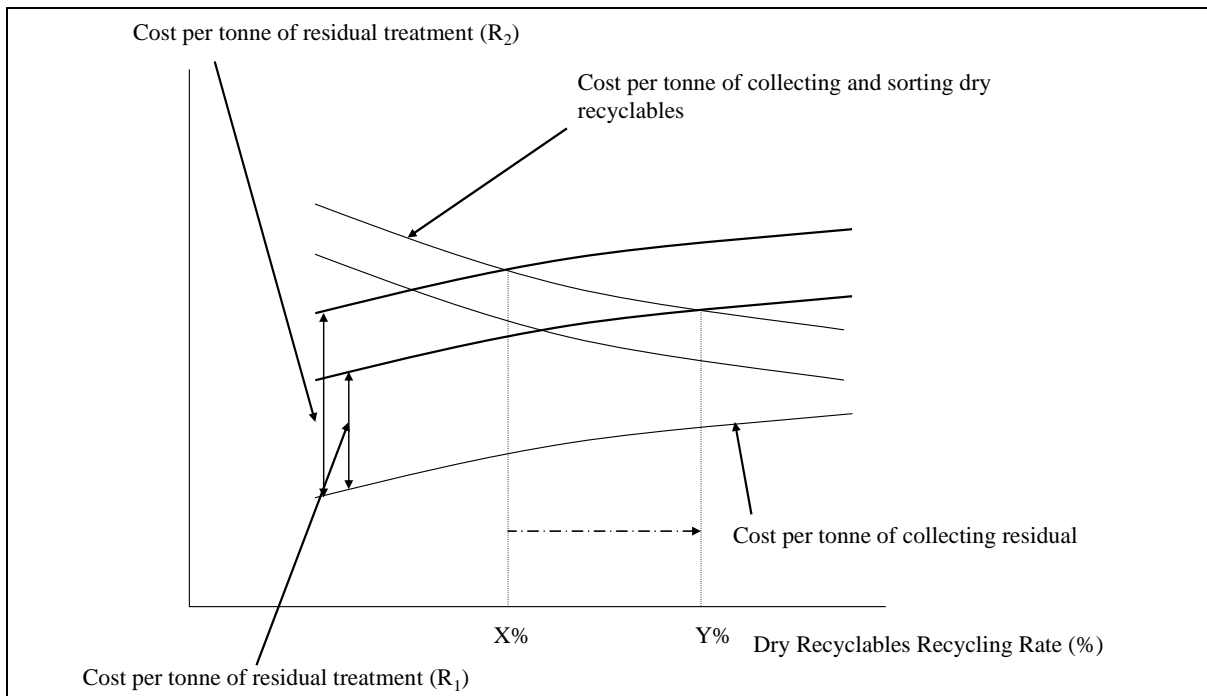
- The question of whether, when, and how one accounts for any additional costs of householder time and effort spent in recycling / home composting remains a matter for discussion (not least because the fact that many engage in the activity in the absence of any charge suggests that some benefit is derived, privately, from the activity). In the absence of some attempt to estimate counterpart benefits which may be derived by private individuals, including the costs of such time may overstate net costs. It is rare, for example, to see studies on costs and benefits of recycling, whether in the context of charging schemes or not, including an estimate of 'consumer surplus' derived from the offer of free (at the point of delivery) recycling services. Willingness to pay studies hint at the possibility that such surpluses may be quite significant. In any case, subject to the economic case being justified,<sup>13</sup> if the costs of householder time are deemed to be significant, the case for comprehensive collections with a high level of convenience is almost certainly strengthened. This includes relatively dense, and well located, networks of container-parks (or similar). These are also likely to reduce the temptation of householders to resort to illegal dumping, especially in the longer term;
- From the perspective of a municipality, the potential to make cost savings through the implementation of recycling schemes increases as the costs of residual waste treatment and / or disposal increase. Because charging schemes tend to encourage a reduction in collected wastes and an increase in the intensity of recycling, the same logic applies. It might be argued, therefore, that charging systems – to the extent that they tend to incentivise more recycling and some waste reduction – are likely to be most attractive to local authorities for whom the costs of collecting materials for recycling and composting are lower than the costs of collecting refuse and sending it for treatment and / or disposal. This is illustrated in Figure 9 for the case of dry recyclables. This shows that as the recycling rate increases, then assuming the materials are collected in constant proportions (and in practice, they will not be), the unit costs of the recycling collections fall as the amount captured per household increases. A shift from X% to Y% can reduce the cost of residual waste collection and treatment at which point recycling becomes the cheaper option (in the Figure, this falls from the cost of collection plus  $R_2$  to the cost of collection plus  $R_1$ ). In other words, one effect of DVR charging may be to strengthen the financial justification for recycling systems by improving the efficiency of the logistics. This point is taken up further below;
- The potential to generate external benefits is dependent upon the extent to which the changes set in train by the DVR scheme lead to positive outcomes. This will be more likely where a) the benefits of recycling are significant and b) where the avoided costs of residual waste treatment / disposal are high. These points are important because the environmental costs and benefits of the various waste management treatments are disputed, and because the performance of the treatments themselves varies with local choices made concerning technology, abatement equipment, energy recovery, materials recovery, etc. Consequently, any study such as this is likely to court some controversy in seeking to pin down external costs and benefits with any degree of certitude (and this is why we have used high and low damage costs to generate ranges rather than single figures). One implication of this, of course, is that if residual waste treatments perform rather better than is suggested here, then the external benefits related to the introduction of a variable charging scheme will be lower than estimated here. This may, of course, come at additional cost (so that the reduction in external benefits may be offset by an increase in the private costs). Few estimates have been produced concerning the benefits of waste reduction. To the extent that materials being consumed are produced from secondary materials, these benefits

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13. This depends, in part, on the relative costs of collection of refuse plus treatment, and the separate collection of materials for recycling / composting or anaerobic digestion (AD).

may be reduced. However, it is not always possible to identify which materials are being reduced when DVR schemes are used.

**Figure 10. Effects on relative costs of changing recycling rate**  
Effects on relative costs of residual waste collection and treatment and dry recyclables collection and sorting



87. Good systems are, perhaps partly by definition, those which are likely to reduce the extent of dumping when DVR charges are implemented. Specifically, variable charging systems are more likely to generate more benefits and fewer costs where the opportunity for collection of materials separately from householders is made available in a manner which is convenient for them. Generally, this means improving door-to-door collections and ideally, having in place a relatively dense network of container-parks, or a network which ensures that people do not have to make special journeys to drop off materials.

## 7.2 Implications for Governments

88. Different countries have adopted different approaches to DVR charging systems. For example, such schemes exist across the nation in South Korea, they will do so in Italy, and in Ireland, charging systems (not always DVR systems) are expected to attain a nationwide coverage. Most other countries allow municipalities to introduce DVR systems without making them mandatory. The UK appears to be unique in making DVR systems illegal for municipalities.

89. Positive experience with DVR systems does not seem to be dependent upon nations demanding that all municipalities introduce such schemes. Indeed, although only time will tell, early accounts of the Irish experience (currently the subject of more comprehensive studies within the Irish Republic), where charging schemes are being made mandatory, have not always been very positive. For reasons already discussed (related to the desirability of convenient kerbside, and other collections for materials), the arguments for such universal application are likely to be strengthened where there are minimum requirements for the provision of separate collection infrastructure which are relatively comprehensive (as in, for example, Flanders in Belgium).

90. Other arguments favouring more widespread use include the potential for reducing the extent of so-called ‘waste tourism’ (*i.e.* the migration of waste across municipal boundaries). This is likely to be further reduced where guidelines on charging structures exist, as they do in Italy, This may help reduce the differentials across municipalities in the marginal costs of disposal.

91. An argument against universal application of DVR schemes would appear to be where households are not required to use any specific collection service. The Irish case may be an example.<sup>14</sup> Arguably, such a situation could be rectified where collection systems were required to achieve minimum standards in terms of service provision, but as long as households are able to opt out of the service provided to them by municipalities, the possibility remains that households simply opt for lowest financial cost (which may not be lowest social cost) solutions. This is made all the more likely in such situations where the municipality does not provide any service itself since the whole cost of the service is paid by the householder in all cases (arguably, in the case where municipalities provide a service, they can make use of locally levied taxes to provide the fixed part of the overall charge).

92. The case for *allowing* (as opposed to *not allowing*) DVR schemes appears to be quite compelling. There are at least two good reasons from the policy perspective:

1. The first is that where residual waste disposal costs are high, the potential of schemes to reduce costs through improving recycling rates and reducing waste can help to reduce costs for municipalities;
2. The second is that they may support other policy objectives. For example, as discussed in this report, producer responsibility schemes which seek to improve rates of recycling of materials collected from the household waste stream, can experience improved rates and efficiencies through the use of DVR charging. Within the UK at present, concerns about failure to meet packaging related targets is already leading the packaging industry itself to call for the use of DVR systems to assist in meeting packaging targets.<sup>15</sup>

93. Whether or not nations seek to make such systems mandatory, national policies can help to support their objectives. For example, as discussed below, many local authorities, whilst they may wish to improve their environmental performance, are ultimately constrained, to a greater or lesser extent, by the financial cost of their services (including taxes). Consequently, national policies – particularly those which internalise negative externalities of residual waste treatment / disposal – have the potential to support implementation of DVR schemes by ‘aligning’ the objectives of municipalities – of lower financial costs – with the national public policy objective of reducing net social costs.

94. It should be noted that whilst many countries implement disposal taxes, it is more difficult – politically – to implement policies which support recycling through first best instruments (since for many countries, primary materials are imported, and their impacts would, ideally, be captured by implementing instruments in the country of origin). Consequently, public authorities have tended to do either, or both, of the following:

- Implement producer responsibility mechanisms; and
- Increase taxes on disposal / treatment of residual waste.

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14. See Martin (2005).

15. See David Davies Associates (2005). It should be noted that the current UK position – that DVR schemes are not allowed by law – is leading both to some authorities seeking to mimic such schemes through creative interpretation of the law, whilst DEFRA has supported so called ‘positive’ incentive schemes (essentially, those which reward good behaviour rather than penalising poor behaviour). On the former, see for example the Blaby case study in Eunomia (2005). This also provides some basic evaluation of other positive incentive schemes.

95. These tend to support recycling.

96. For Governments, therefore, on balance, there is probably no need to *demand* that charging systems are introduced. The desirability of variable charging, as discussed above, has to consider the service which the charging system functions within, and this will vary locally.

### 7.3 *Implications for local authorities*

97. For local authorities, as discussed above, one important constraint is the financial costs of any system. For local authorities, DVR systems can reduce these, though they will not always do so. Whether or not they do so is dependent, as hinted at above, upon the differential between:

- The costs of residual waste collection and its treatment / disposal; and
- The costs of separate collection of materials for recycling and composting / anaerobic digestion.

98. The issue is complicated somewhat by the existence of system effects. Charging systems can, as both the Landkreis Schweinfurt and Ghent examples show, lead to a reduction in the frequency of set-out of residual waste, leading to savings in collection logistics. Typically, these reductions in the frequency of refuse collection go hand-in-hand with improved separation of the most putrescible fraction, the food waste fraction, which causes most problems (odour etc.) if collected infrequently.

99. This latter point is an important one concerning the design of charging structures. Where possible, municipalities should seek to design charging structures which achieve the best compromise between:

- Incentivising behaviour which minimises external costs; *and*
- Incentivising behaviour which reduces the financial costs of the waste management system.

100. This reinforces the point made above concerning internalisation of negative externalities. It also suggests that charging systems should consider not simply ‘volume’, or ‘weight’ as the basis for charging, but, importantly for collection logistics, the frequency of collection, especially of residual waste. This is because collection costs depend significantly upon the frequency of set-out of materials by households.<sup>16</sup> To the extent that charging systems may encourage improved segregation of putrescible materials, this can make lower-frequency collection of residual wastes less problematic (in terms of odours, pests, etc.) as long as the material is adequately contained.

101. Because the potential for making financial savings is related to the avoided costs of residual waste collection and its treatment / disposal, this potential will be diluted significantly where municipalities have entered into contracts for residual waste treatment and /or disposal which effectively make the marginal cost of treatment / disposal equal to zero. This may be where contracts for minimum tonnages have been agreed in the past, or where there is an excess of capacity for treatment in the local context. In these municipalities, the net social costs of DVR schemes are likely to be less positive since savings on the financial cost side will be more difficult to make.

102. Also reflecting previous discussions, municipalities are likely to experience fewer negative side-effects of DVR schemes – illegal dumping, and increases in time spent, and fuel used, by households in transporting wastes for recycling – if the quality and convenience of provision of separate collection systems is made a priority (kerbside, bring and container-park ). The willingness, or ability, of municipalities to do this will reflect local policies and markets and their perception of affordability. The

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16. As a rule of thumb in the UK, we expect the costs of fortnightly residual waste management to be approximately two-thirds that of weekly collection. A similar finding is implied by Hummel in work for the UK Cabinet Office – see Hummel (2002).

potential for dumping to emerge as a problem may also be affected by the approach to enforcement. Well-designed enforcement is likely to go hand in hand with the provision of appropriate information in advance of a scheme's introduction. Following scheme introduction, reflecting the possibility of early 'protest' actions, early enforcement, and preparation for such, is important. Whilst the widespread discussion of reports of illegal dumping resulting from DVR schemes may or may not overstate the potential outcomes, such discussions have served to heighten awareness of the possibilities. This enables municipalities to be better prepared to counter such impacts when they introduce DVR schemes.

103. Difficulties in making effective implementation of DVR schemes may be experienced by:

1. Municipalities which operate in jurisdictions in which households are not necessarily linked to the waste collection system provided by, or on behalf of, municipalities. This is because households may be free to simply 'sidestep' the DVR scheme;
2. Municipalities which are very small may be more susceptible (or more correctly, their neighbours are) to problems of waste tourism;
3. Municipalities seeking to recover all the costs of service provision through revenues from charges with a variable element. This can lead to the following problems:
  - a) insufficient revenue being collected to cover the costs of service provision; and
  - b) greater competition from private sector providers offering lower cost, and lower quality, services.

104. Municipalities are, as hinted at above, essential players in delivering producer responsibility take-back obligations under, for example, producer responsibility measures. For many products / materials / wastes, the most efficient infrastructure for take-back is the municipal waste management system. DVR charging systems can enhance the efficiency of capture of these materials through existing systems and so either reduce the costs of achieving specific objectives, or increase the performance of systems implemented to achieve producer responsibility.

105. Municipalities can also play a role in helping to reduce waste arisings. Previous studies of DVR schemes have hinted at some degree of scepticism regarding the potential for citizens to genuinely reduce waste arisings (these include the studies of Fullerton and Kinnaman, those of the Danish EPA and that of the Dutch Ministry for the Environment). However, it is clear that DVR schemes, especially those affecting biowaste, increase the quantities of biowaste dealt with through home composting. The effect is not limited to biowaste, however. Indeed, one study, which undertook a range of interviews of some multinational companies, noted the response of one such enterprise:

*French consumers apparently do not mind buying flexible (i.e. non-rigid) packaging (e.g. coffee) with which they can refill an existing glass jar, whereas UK consumers prefer to buy one-way tin cans and glass jars. The desire to buy such packaging is also highly prevalent in Switzerland, but this time for economic reasons. For example, in Zurich and Berne, householders have to pay 1.50 Swiss Francs per refuse bag. ... there is therefore a definite economic incentive to them buying as much lightweight flexible packaging as possible.*

106. It seems reasonable to suggest, therefore, that where marginal costs of disposal are high, there is a direct incentive to reduce waste generation through purchasing decisions.

107. Finally, it should be noted that for municipalities, there are benefits beyond those which are the proper domain of cost-benefit analysis. For example:<sup>17</sup>

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17. See Eunomia (2003).

1. The movement of commercial waste into appropriate channels may be seen as a benefit to the extent that municipalities and their citizens no longer cross-subsidise the management of commercial and industrial wastes;
  2. Better data concerning waste arisings (this is as much a necessary component of the system as it is a consequence of its being in place);
  3. A perception of greater fairness in that producers of large amounts of waste pay more;
  4. The possibility to oversee the activities of collection crews more closely, and to re-configure logistics accordingly (independently of any consideration concerning changes in quantities). This includes the possibility of ‘checking up’ on extreme behaviours as exhibited by specific households commercial properties;<sup>18</sup> and
  5. Transparency of costs. It is difficult, if schemes are intended as schemes to cover costs, to sidestep the need for a clear understanding of the costs of the waste management system. Furthermore, contractual payments can be made on a more appropriate basis in line with balances of fixed and variable elements of an overall fee.
108. The last of these may be perceived by some interest groups as a *disbenefit* rather than a benefit, precisely because some groups benefit from a lack of cost transparency. To the extent, however, that one seeks to implement high quality public services, cost transparency and value for money issues seem to be important issues, and further reasons to consider DVR schemes (though other means of improving this exist).

#### 7.4 *Questions raised by the study*

109. The study raises a number of questions concerning the evaluation of, and the operational performance of, DVR charging systems. These are discussed below with a view to highlighting the need for further research and investigation. Operational issues are discussed first since these necessarily have a bearing upon evaluation (whether through cost-benefit analysis or other approaches).

##### 7.4.1 *Operational issues*

110. The following issues are of relevance:
1. The hypothesis of this study – that the reduction in collected household waste results, to some extent, from the movement of commercial waste out of the municipal collection system – deserves to be more closely tested. In other contexts, where municipalities seek to reduce commercial waste entering the household waste stream (for example, at container-parks<sup>19</sup>), there is some evidence that considerable changes can occur. There is a clear need to carry out further research to seek to understand the potential magnitude of the hypothesised effect when DVR schemes are established. This would necessarily need to occur in the context of more detailed evaluations (see below for discussion of the need for more such evaluations);
  2. Elsewhere, we have noted the potential for further improvement in the optimisation of costs for waste collection. Different DVR schemes employ collection schemes with different levels of

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18. Strictly speaking, it is not absolutely necessary to apply charging to do this since identification schemes without charges ought also to allow such improvements to be made.

19. Recent UK experience at container-parks (called, variously, civic amenity sites, household waste recycling centres, etc.) shows that these sites – intended for households only – tend to be abused by commercial users. One major waste authority recently commented (privately) that it had, through targeted actions affecting commercial waste, reduced waste by 200,000 tonnes.

materials coverage. In some cases, the scope of collections can be linked to the existence of specific producer responsibility measures. However, more generally, as mentioned above, DVR schemes will generate the greatest benefits where the costs of a waste management system with a high level of service provision for separate collection of materials compares favourably with a scheme where the majority of waste is collected as refuse for subsequent treatment / disposal. This raises this broader question of the design of efficient and cost effective logistics. Design of logistics should account for the relative costs of labour and capital in the countries concerned, and should seek to match vehicles and containment systems, as well as collection frequencies, to the nature of materials being collected.

#### 7.4.2 *Evaluation issues*

111. There are a very large number of studies which provide information on the outcomes of DVR charging systems. There are also attempts to understand, often through meta-analysis (though sometimes through household interviews) the impacts of charging systems. However, there are relatively few detailed studies in the public domain of specific municipalities' experience. There are fewer still which follow a DVR scheme from the pre-implementation phase through the implementation phase, and examine this in the short- and long-term following implementation. If such studies do take place, as in policy evaluation in other fields, disentangling the effects of the policy from wider changes would be problematic, but this should not deter researchers from undertaking such studies.

112. Key issues remain as follows:

1. There have been few, if any, studies concerning the external costs of fly-tipped waste. Probably, these are quite site specific and would be expected to be larger where they are either:
  - a) Causing physical harm to the environment; and/or
  - b) Creating disamenity impacts – either visual or in terms of pests – for a large number of citizens.

In any case, it is recognised that the *private* costs of clean-up are, for fly-tipped waste, quite high. In the absence of estimates of externalities, given that the clean-up costs for fly-tipped waste may be quite high, these private costs may be a proxy for the externalities (which may be avoided through speedy action);

2. A somewhat problematic issue in the assessment of costs and benefits has been how to address the issue of additional time spent by householders in activities motivated by DVR charging systems. This issue was considered problematic on a number of levels:
  - a) Whether to include it at all in the absence of any counterpart benefit – possibly of a ‘warm glow’ nature – reflecting the value to householders of participating more fully in recycling;
  - b) To what extent is any additional time spent associated with the collection system itself, or the charging system's effects upon it? and
  - c) If including it, at what ‘hourly rate’ to impute the value of time to householders.

These questions are deserving of further examination, not least since time costs may be significant. On the one hand, these may reduce the net benefits associated with DVR schemes where collection systems are less convenient. On the other, it may be that (irrespective of DVR schemes) they justify investment by municipalities in more convenient collection systems.

3. Finally, the analysis of costs and benefits has been based upon estimates of the external costs of different management options which will be, inevitably, controversial. Additional work is unlikely to remove the element of controversy. However, the data upon which the estimates of the benefits of recycling have been based are rather dated. There is a need for improved data in this regard, and for this to be made publicly available (so that the data is open to challenge). Furthermore, as regards some of the residual waste treatments, the picture is becoming more colourful with a range of treatments now being widely used upon which few studies have been undertaken. To our knowledge, there is only one cost-benefit study which has looked at

mechanical-biological treatment plants. Given that this technology is being more widely deployed (notably in Italy, Germany and Austria, but increasingly in Spain and the UK), some estimate of external costs is warranted. Their performance relative to other treatments is likely to be affected significantly by, for example (where materials are stabilised prior to landfilling), the assumptions regarding performance of landfills in terms of gas capture. Also lacking are studies estimating the benefits of waste reduction.

## REFERENCES

- AEA Technology (1997) *Economic Evaluation of the Draft Incineration Directive, Report for DGXI*, European Commission, Luxembourg: Office for the Official Publications of the European Union.
- AEA (2001) *Health Effects of Composting A Study of Three Compost Sites and Review of Past Data*, Environment Agency Technical Report P1-315/TR.
- AEAT Environment (2005) *Damages per tonne Emission of PM<sub>2.5</sub>, NH<sub>3</sub>, SO<sub>2</sub>, NO<sub>x</sub> and VOCs from Each EU25 Member State (excluding Cyprus) and Surrounding Seas*, Report to DG Environment of the European Commission, March 2005.
- Amlinger, F., M. Ricci, E Favoino and D. Hogg (2004) *Handbook for Management of Biowastes: Manual for Slovak Municipalities and Local and Regional Authorities*, Final Report to the Slovak Ministry of the Environment, [http://www.enviro.gov.sk/minis/odpady/aktu/brko\\_eng.pdf](http://www.enviro.gov.sk/minis/odpady/aktu/brko_eng.pdf).
- AOO (2001), *Afval Informatief, Informatiebulletin*, 06, Juin 2001.
- Atech (1999), *Variable Rate Charges for Domestic Waste Collection*, prepared for Hunter Waste Planning and Management Board on behalf of the NSW regional waste boards, May 1999
- Bartelings, H., (2003) *Municipal Solid Waste Management Problems, An Applied General Equilibrium Analysis*, PhD Thesis, University of Wageningen.
- Bartelings, H., P. van Beukering, O. Kuik, V. Linderhof, F. Oosterhuis, L. Brander and A. Wagtendonk (2005) *Effectiveness of Landfill Taxation*, R-05/05, Report Commissioned by Ministerie von VROM, November 24, 2005.
- BDA Group and EconSearch (2004) *Analysis of Levies and Financial Instruments in relation to Waste Management*, Final Report to Zero Waste SA, 25 October 2004.
- Bigliardi, P. (1998), "Frazione umida compostabile da utenze domestiche. Esperienze e prospettive", Proceedings of RICICLA '98, Maggioli Editore, Rimini, Italy 1998.
- Björklund, A. (1998) *Environmental Systems Analysis Waste Management*. Licentiate Thesis. Royal Institute of Technology, Stockholm.
- Brisson, Inger, and David Pearce (1995) Benefits Transfer for Disamenity from Waste Disposal, *CSERGE Working Paper WM 95-06*, London: CSERGE
- Brisson, I. E., (1997) *Assessing the Waste Hierarchy – a Social Cost-Benefit Analysis of Municipal Solid Waste Management in the European Union*, <http://www.akf/eng/waste1.htm>.
- Brisson, Inger, and Jane Powell (1995) *Dump or Burn? – the Assessment of Social Costs and Benefits of Waste Disposal*, CSERGE, University College of London and University of East Anglia.

- Broome, E., P. Vaze and D. Hogg (1999) *Beyond the Bin: The Economics of Recycling*, Final Report to Waste Watch;
- Bruvoll, A. (1998) Taxing Virgin Materials: An Approach to Waste Problems, Resources, *Conservation and Recycling*, 22, pp.15-29;
- Bruvoll, A., B. Halvorsen and K. Nyborg (2000) Household Sorting of Waste at Source, *Economic Survey* 4/2000, pp.26-35
- Bruvoll, A., B. Halvorsen and K. Nyborg (2002), Households' Recycling Efforts, Resources, *Conservation and Recycling*, 36: 337-354.
- Bulletin from the Danish Environmental Protection Agency No. 3, 2000 Statistics on Waste 1998 (83% of the recorded amount of refuse distributed on 2,406,968 households);
- Bulletin from the Danish Environmental Protection Agency No.17, 2001; Statistics on Waste 1999 (85% of the recorded amount of refuse distributed on 2,406,968 households).
- Cambridge Econometrics in association with EFTEC and WRc (2003) *A Study to Estimate the Disamenity Costs of Landfill in Great Britain*, London:Defra, February 2003.
- Casella Science and Environment (2001) *Monitoring the Environmental Impacts of Waste Composting Plants*, Environment Agency Technical Report P428.
- CIEMAT (ed.) (1998) *ExternE Externalities of Energy – National Implementation*. CIEMAT: Madrid.
- Clarkson, R. and K. Deyes (2002) *Estimating the Social Costs of Carbon*, Government Economic Service Working Paper 140, [www.hm-treasury.gov.uk/media/209/60/SCC.pdf](http://www.hm-treasury.gov.uk/media/209/60/SCC.pdf).
- Coll Gelabert, Enric, (2003) The Successful Separate Collection Experiences in Catalonia. The Door to Door Collection, *Presentation to the International European Composting Network (ECN) Workshop on 'The Future of Source Separation of Organic Waste in Europe'*, Barcelona, Spain, 15<sup>th</sup>/16<sup>th</sup> December 2003.
- Coopers & Lybrand, CSERGE and EFTEC (1997) *Cost-Benefit Analysis of the Different Solid Waste Management Systems: Objectives and Instruments for the Year 2000*, Luxembourg: Office for Official Publications of the European Communities.)
- COWI (2000) *External Costs of Landfill and Incineration*, Final Report to the European Commission.
- Crapanzano, G., L. Dei Furia, S. Ascari, M. Fontana, A. Lorenzoni and F. Mmaugliani (1998) *ExternE National Implementation*, Milan: Italy.
- CSERGE and EFTEC (1998), *Life Cycle Research Programme for Waste Management: Damage Cost Estimation for Impact Assessment*, Report to the Environment Agency.
- Danish Environmental Protection Agency (2000) Fordele og ulemper ved gebyrdifferentierede indsamlingssystemer for husholdningsaffald. *Miljøprojekt nr. 576*, 2000. (Study on the advantages and disadvantages of fee-differentiated waste collection schemes for domestic waste from households). [www.mst.dk/udgiv/publikationer/2000/87-7944-317-6/pdf/87-7944-318-4.pdf](http://www.mst.dk/udgiv/publikationer/2000/87-7944-317-6/pdf/87-7944-318-4.pdf).
- Danish EPA (2003): *Skal husholdningernes madaffald brændes eller genanvendes? Samfundsøkonomisk analyse af øget genanvendelse af organisk dagrenovation* (Is the food waste from the households to

- be incinerated or recycled? A welfare-economic analysis of increased recycling of organic household waste.) *Environmental project no. 814*. [www.mst.dk/udgiv/publikationer/2003/87-7972-685-2/html/](http://www.mst.dk/udgiv/publikationer/2003/87-7972-685-2/html/); J
- David Davies Associates (2005) *Packflow 2008: UK Compliance with the 2008 Targets of the European Packaging and Packaging Waste Directive*, July 2005, <https://www.valpak.co.uk/nav/page1189.aspx>
- Dijkgraaf, E. and R. H. J. M. Gradus (2003) Cost Savings of Unit-based Pricing of Household Waste: The Case of the Netherlands, *Research Memorandum 0209*, OCFEB, Erasmus University, Rotterdam
- Dijkgraaf, E., and R. H. J. M. Gradus (2004) Cost Savings in Unit-based Pricing of Household Waste: The Case of The Netherlands, *Resource and Energy Economics*, Vol.26 (2004) 353-71 (note, the former paper is somewhat more extensive in its treatment)
- Dijkgraaf, E. and H. Vollebereggh (2005) Literature Review of Social Costs and Benefits of Waste Disposal and Recycling, in *Rethinking the Waste Hierachy*, EAI: Copenhagen, pp. 80-98.
- Dijkgraaf, E., and H. Vollebergh (2004) Burn or Bury? A Social Cost Comparison of Final Waste Disposal Methods, *Ecological Economics*, 50, pp.233-247.
- Doberl, G., R. Huber, P. Brunner, M. Eder, R. Pierrard, W. Schonback, W. Fruhwirth, H. Hutterer (2002), "Long-term Assessment of Waste Management Options – a New, Integrated and Goal-Oriented Approach". *Waste Management & Research*, Vol. 20, No. 4, 311-327.
- EcoAlternatives (2004) *Evaluation of the Costs and Benefits of Collecting Metal Packaging in Multi-material Kerbside Collections*, Final Report to DTI, December 2004.
- ECOTEC and CSERGE (1999) *Policy Instruments to Correct Market Failure in the Demand for Secondary Materials*, Final Report to DETR.
- Environmental Protection Agency of Region Veneto (ARPAV) (2004) Castelfranco Veneto, Regional Observatory for Waste and Composting (Treviso, Italy), 2004 Italy.
- Enviros and EFTEC (2004), *Valuation Of The External Costs And Benefits To Health And Environment Of Waste Management Options*. Final Report for Defra, December 2004, <http://www.defra.gov.uk/ENVIRONMENT/waste/research/health/pdf/costbenefit-valuation.pdf>
- Eunomia (2002), *Costs for Municipal Waste Management in the EU*, Final Report to DG Environment, European Commission, <http://europa.eu.int/comm/environment/waste/studies/pdf/eucostwaste.pdf>.
- Eunomia Research & Consulting, Scuola Agraria del Parco di Monza, HDRA Consultants, ZREU and LDK ECO on behalf of ECOTEC Research & Consulting (2002), *Economic Analysis of Options for Managing Biodegradable Municipal Waste*, Final Report to the European Commission.
- Eunomia (2003), *Waste Collection: To Charge or Not to Charge?* A Final report to IWM (EB), <http://www.eunomia.co.uk/Charging%20report.pdf>.
- Eunomia (2004), *Current Practice in the Collection of Organic Wastes*, Final Report to Devon County Council ([www.eunomia.co.uk](http://www.eunomia.co.uk)).
- Eunomia (2004b), *Compulsory Recycling Scheme Review and Second Phase Roll Out Plan*, Final Report to the London Borough of Barnet.

- Eunomia (2005), *Household Waste Incentive Schemes: Case Study Overviews*, <http://lasupport.defra.gov.uk>.
- Eunomia (2006a), *A Changing Climate for Energy from Waste?* Final Report for Friends of the Earth, May 2006.
- Eunomia (2006b, forthcoming) *Kerbside Organics Good Practice Guide*, Final Report to WRAP.
- Favoio, E. (1999), "Composting in Italy: the use of biodegradable bags to optimise source separation", in A. Beevers (Ed.) (1999), *Proceedings of the Biodegradable Plastics 99 Conference*, Frankfurt am Main, Germany, April 1999. *European Plastic News*, Croydon, UK.
- Favoio, E., M. Ricci and F. Giro de Fontanals (2003), *Innovative Schemes for Cost-optimised Source Separation of Biowaste*. Paper Presented to the ISWA Beacon Conference on The Biological Treatment of Waste and its Role in Integrated Waste Management: New Challenges and Strategies, Paris-Nord/Villepinte, 4-5 December 2003.
- Fullerton, D. and T. C. Kinnaman (1996) Household Responses to Pricing Garbage by the Bag, *American Economic Review*, September 1996, pp.971-984.
- Fullerton, Don, and Amy Raub (2003) Economic Analysis of Solid Waste Management Policies, in OECD (2004) *Addressing the Economics of Waste*, Paris: OECD).
- GUA, AWS and IFIP (2000) *Bewertung Abfallwirtschaftlicher Maßnahmen mit dem Ziel der Nachsorgefreien Deponie (BEWEND)*, Final Report, Vienna, November 2000. An English summary is available – G. Doberl, R. Huber, P. Brunner, M. Eder, R. Pierrard, W. Schonback, W. Fruhwirth, H. Hutterer (2000) *Long-term Assessment of Waste Management Options – a New, Integrated and Goal-Oriented Approach*.
- Hellweg, S. (2000) *Time- and Site-Dependent Life-Cycle Assessment of Thermal Waste Treatment Processes*, Dissertation submitted to the Swiss Federal Institute Of Technology.
- HM Customs & Excise (2004) *Combining the Government's Two Health and Environment Studies to Calculate Estimates for the External Costs of Landfill and Incineration*, December 2004.
- Hogg, Dominic *et al.* (2000) *Beyond the Bin: The Economics of Recycling*, [www.wastewatch.org](http://www.wastewatch.org).
- Hogg, Dominic *et al.* (2002) *Economic Assessment of Options for Dealing with Biodegradable Waste*, Report to DG Environment, European Commission, by Eunomia, Scuola Agraria del Parco di Monza, HDRA Consultants, ZREU and LDK.
- Hogg, Dominic *et al.* (2002b) *Comparison of Compost Standards Within the EU, North America and Australasia*, Final Report to WRAP. [www.wrap.org.uk/downloads/Compost\\_Standards\\_Section\\_1.be0674ca.pdf](http://www.wrap.org.uk/downloads/Compost_Standards_Section_1.be0674ca.pdf).
- Hogg, Dominic *et al.* (2002c) *Costs for Municipal Waste Management in the EU*, Final Report to DG Environment, European Commission (Annexes to the report). <http://europa.eu.int/comm/environment/waste/studies/pdf/eucostwaste.pdf>
- Hummel, J. (2002) *Collection Cost Projections*, Report to the Cabinet Office Strategy Unit, Dec. 2002
- Jakus P. M., *et al.* (1996) Generation of Recyclables by Rural Households, *Journal of Agricultural and Resource Economics*, Vol 21 (1), pp 96-108.

- KPMG Bureau voor Economische Argumentatie (2001) *Gedragseffecten van Tariefdifferentiatie*. The Hague: KPMG.
- Linares, P., M. Arostegui, J. Leal, Y. Lechon, R. M. Saez, M Varela, A. Alarcon, S. Salat, N. Sumarroca, J. Montes, L. Munoz and A. Ramos (1998) *ExternE National Implementation. Spain*. CIEMAT: Madrid.
- Linderhof, V., P. Kooreman, M. Allers and D. Wiersma (2001) Weight-based Pricing in the Collection of Household Waste: The Oostzaan Case, *Resource and Energy Economics*, 23, pp.359-71;
- Markandya, Anil (1998), *The Indirect Costs and Benefits of Greenhouse Gas Limitation*, Report prepared for the UNCCEE, Roskilde, DK.
- Martin, Duncan (2005), The True Cost of Irish Pay-by-use, *Wastes Management*, October 2005, pp.42-5.
- Miranda, M.-L. and S. LaPalme (1997) *Unit Pricing of Residential Solid Waste: A Preliminary Analysis of 212 U.S. Communities*, June 4, 1997, Nicholas School of the Environment, Duke University. (For a review of US Literature)
- Miranda, M.-L. S. Bauer and J. Aldy (1996) *Unit Pricing Programmes for Residential Municipal Solid Waste: An Assessment of the Literature*, Report prepared for Office of Policy, Planning and Evaluation, U.S. Environmental Protection Agency, Washington, D.C. 20460, March 1996
- Nolan ITU (2004) *TBL Assessment of Garden Organics Management*, Final Report to the NSW Dept of Environment and Conservation, Sustainability Programs Division, May 2004.
- Nolan-ITU *et al.* (2001) *Independent Assessment of Kerbside Recycling in Australia*, Volume 1, Manly NSW: Nolan-ITU and SKM.
- NSW Department of Environment and Conservation (2004), *Producing and Consuming Efficiently to Conserve our Resources*.
- Palmer, K., and M. Walls (1999) Extended Product Responsibility: An Economic Assessment of Alternative Policies, *Discussion Paper 99-12*, January 1999, Washington DC: Resources for the Future
- Pearce, D. (2004) Does European Waste Policy Pass a Cost-benefit Test? in Environmental Assessment Institute (2005) *Rethinking the Waste Hierarchy*, EAI: Copenhagen pp.60-79
- Porter, Richard C. (2004), Efficient Targeting of Waste Policies in the Product Chain, in OECD (2004) *Addressing the Economics of Waste*, Paris: OECD.
- Porter, Richard C. (2005), Benefit-cost Analysis and the Waste Hierarchy – US Experiences, in Environmental Assessment Institute (2005) *Rethinking the Waste Hierarchy*, EAI: Copenhagen.
- Powell J.C., Craighill A.L., Parfitt J.P. and Turner R.K. (1996), A Lifecycle Assessment and Economic Valuation of Recycling, *Journal of Environmental Planning and Management*, Vol 39 (1), pp.97-112.
- Powell, J. C., David Pearce and Inger Brisson (1995), Valuation for Life Cycle Assessment of Waste Management Options, *CSERGE Working Paper WM 95-07*.

- Proietti, Stefano (2000), *The Application of local Taxes and Fees for the Collection of Household Waste: Local Authority Jurisdiction and Practice in Europe*, Report for the Association of Cities for Recycling, Brussels: ACR
- Provincia di Milano (1998), *Analisi merceologiche delle frazioni umida e secca in Provincia di Milano*. In: Il Quaderno: Gestione Rifiuti Solidi Urbani 1998; Indirizzi Programmatici e Azioni di Approfondimento, Milan, Italy 1998.
- Puig Ventosa, Ignasi (2002), Pago por Generación de residuos Municipales en Torrelles de Llobregat, *Equipamiento Servicios Municipales*, Año 19, No. 104, 2002, pp.20-29;
- Puig Ventosa, Ignasi (2003), Torrelles Aporta: El Porta a Porta y la Tasa de Pago por Generación de Residuos Municipales en Torrelles de Llobregat (unpublished mimeo).
- Puig-Ventosa, Ignasi (2006), Fee and Rebate Systems to Foster Ecologically Sound Urban Waste Management, in *Critical Issues in Environmental Taxation: International and Comparative Perspectives, Vol III*, pp.524-29.
- Rabl, J. V. Spadaro and P. D. McGavran (1998) Health Risks of Air Pollution from Incinerators: A Perspective, *Waste Management and Research, Vol 16*, pp.365-388.
- Radetzki, M. (2000) *Fashions in the Treatment of Packaging Waste: An Economic Analysis of the Swedish Producer Responsibility Legislation*, Brentwood: Multi Science;
- Repetto, R., R. C. Dower, R. Jenkins and J. Geoghan (1992) *Green Fees: How a Tax Shift Can Work for the Environment and the Economy*, Washington DC: World Resources Institute.
- RIVM, EFTEC, NTUA and IIASA with TME and TNO (2000) Technical Background Report 7: Municipal Solid Waste Management, in RIVM, EFTEC, NTUA and IIASA with TME and TNO (2000) *European Environmental Priorities: An Integrated Economic and Environmental Assessment*, Report to DG Environment, European Commission.
- RPA (Risk and Policy Analysts) and Metroeconomica (1999) *Induced and Opportunity Cost and Benefit Patterns in the Context of Cost-Benefit Analysis in the Field of Environment, Final Report to European Commission*, DG III, February 1999.
- Sauer, Petr, Libuse Parizkova, Petr Fiala, Antonin Dvorak, Erik Geuss, Jiri Hrebicek, Alena Hadrabova and Simon Budsky (2003) *To PAY[T] or Not to PAY[T] for Household Waste? Results of Statistical Surveys in the Czech Republic*,
- SILE -IPLA (2002), *Realizzazione di indagini merceologiche su differenti flussi di rifiuti*, Lecco, Italy.
- Skinner, Thomas and Don Fullerton (1999), The Economics of Residential Solid Waste Management, *NBER Working Paper 7326* <http://www.nber.org/papers/w7326>
- Skumatz, Lisa (2002) *Variable Rate or 'Pay-as-you-throw' Waste Management: Answers to Frequently Asked Questions*, Los Angeles: Reason Foundation, July 2002
- Smith, S., (2005) *Analytical Framework for Evaluating Costs and Benefits of EPR Programmes*, Report for OECD Working Group on Waste Prevention and Recycling, ENV/EPOC/WGWPR(2005)6/FINAL, [http://appl1.oecd.org/olis/2005doc.nsf/linkto/env-epoc-wgwpr\(2005\)6-final](http://appl1.oecd.org/olis/2005doc.nsf/linkto/env-epoc-wgwpr(2005)6-final).

- Sterner, T. and H. Bartelings (1999) Household Waste Management in a Swedish Municipality: Determinants of Waste Disposal, Recycling and Composting, *Environmental and Resource Economics*, 13, pp. 473-91.
- Sundqvist, J-O et al (2002) Hur Skall hushallsavfallet tas omhand – Utvärdering av olika behandlingsmetoder (How Shall Municipal Solid Waste be Disposed – Assessment of Different Treatment Methods) Stockholm February 2002. *IVL report B 1462*;
- TemaNord (2004) Värdisætning af skadesomkostninger ved affaldsforbrænding - en analyse af dioxiners skadelige effekter og et regneeksempel på disse effekters samfundsøkonomiske omkostninger, TemaNord 2004:518, Nordisk Ministerråd, København 2004.
- Thorgersen, John (1994) *Monetary Incentives and Environmental Concern: Effects of a Differentiated Garbage Fee*, CeSaM Working Paper No.2, September 1994
- Tiller K. H., et al. (1997) Household Willingness to Pay for Dropoff Recycling, *Journal of Agricultural and Resource Economics*, Vol 22 (2), pp 310-320).
- USEPA (1998) *Illegal Dumping Prevention Guidebook*, EPA-905-B-97-001, March 1998.
- USEPA (2002) *Solid Waste Management and Greenhouse Gases: A Life-cycle Assessment of Emissions and Sinks*, 2<sup>nd</sup> Edition, EPA530-R-02-006, May 2002.
- USEPA (2003) *Background Document for Life-Cycle Greenhouse Gas Emission Factors for Carpet and Personal Computers*, EPA530-R-03-018 November 21, 2003
- VROM 1997. *Ervaringen met Tariefdifferentiatie en Huishoudelijk Afval* (“Experience with differentiated tariffs and domestic waste”). Ministry of Environmental Affairs, Den Haag.
- Zelle, Rogier & Van Der Zwaan, Rogier, (1997), *Ervaringen met tariefdifferentiatie en huishoudelijk afval*, VROM, Zoetermeer, p. 66.

## ANNEX 1: REVIEW OF COST-BENEFIT STUDIES OF DVR CHARGING SCHEMES

113. A number of authors have investigated the theoretical merits of different policy instruments for dealing with municipal waste. DVR Charging has typically been considered in this context.

114. Only a few studies have actually sought to understand the costs and benefits of DVR charging systems. Some of these are considered in this section.

### A.1.1 Fullerton and Kinnaman

115. Fullerton and Kinnaman (1996) attempted a cost-benefit analysis of a pay-per-bag system in Charlottesville, Virginia. The scheme was a pay-per-bag scheme affecting the price of refuse collection only, and was started in 1992. From the study, it appears that households were offered the potential to recycle a range of materials through a kerbside recycling scheme, but no service appears to have been available for collecting segregated biowaste from the kerbside or doorstep. The study also indicates that there were two drop-off schemes serving the 40,000 inhabitants. They report that the scheme reduced the weight of refuse collected by 14%, the volume of refuse by 37% and increased recycling by 16%.

116. An important feature of the study was that it made actual measurements of the weight and volume of waste generated by households before and after the scheme's introduction. The sample of respondents providing complete data (in response to questions) was 75 in a population of just over 40,000. Importantly, the study notes:

*'With only a 25-percent positive response rate, our sample could suffer from a self-selection bias. Perhaps only educated, environmentally-aware households would agree to have their garbage weighed. These households may already have been recycling as much as they could before unit pricing with little opportunity for additional recycling. Conclusions based on such a sample might understate the reduction in garbage of an average household. .... We cannot compare our sample's garbage per capita to the city's data on "residential" garbage per capita, because the latter includes garbage from small businesses that use bags, and includes population from apartments that use dumpsters'*

117. One of the study's objectives was to understand the nature of householder responses to the DVR charging scheme. Significant effort was devoted to understanding the potential causes of illegal dumping. It should be noted that the aggregated weight of the refuse and recyclable materials collected before and after the scheme changed from 14.59 lbs per capita per week to 13.64 lbs per capita per week, a net reduction of 7%.<sup>20</sup>

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20. It should be noted that the study includes some estimates as to trends in waste collected in other jurisdictions in the same period and finds a reduction of 3.5% over the same period in other municipalities in Virginia. Noting that such reductions may be seasonal, and related primarily to garden waste collected, the study notes that attempts were made to exclude garden waste from the analysis, and so dismisses the likelihood that the observed waste reduction should be adjusted to account for happenings elsewhere. The authors state: *'care was taken throughout the term of the study not to weigh yard waste. This involved inspection of household garbage, which was not a difficult task'*. Actually, this is usually quite a difficult

118. In seeking to estimate the extent for illegal dumping within the 75 households, two approaches were used. Both revolved around asking households whether, and if so, how, they reduced refuse set out for collection. Five possibilities were offered, one of which was 'other'. The authors hypothesise that:

*'Since the first four options would seem to cover all legal alternatives, we think the "other" option is a strong indicator of illegal disposal.'*

119. On the basis of this assumption, the 4 households who made a response, and who did not set out any refuse over a 4-week measurement period, were assessed for the change in quantity of material they set out after the scheme as opposed to before. The second approach looked at all 7 households who reported that they used 'other' means.

120. The 'missing garbage', according to the study, accounted for 28-43% of the overall reduction in the set out of waste. Taking into account the total reduction of 7% of waste, illegal dumping was deemed to have accounted for between 1.8-2.8% of all the pre-scheme waste collected from households.

121. There are a number of problems with this estimate, not least is the fact that it is based upon survey responses related to no more than 7 households. In addition, the earlier comment of the authors – that residential waste may include some commercial waste – is not reflected in the approach. It may have been the case that some of the householders were using their residential collection to manage some of their commercial waste before the scheme (though the survey process may have made them less likely to do this). Finally, there remains the possibility that some households genuinely *do* produce no garbage. Indeed, they might be expected to behave rather better than normal when being surveyed. Investigations elsewhere by municipalities in Italy have indeed suggested that some households become 'zero waste' householders.

122. None of this be quite so worrying were it not for the fact that the result is frequently cited by later studies which have sought an estimate of the likely extent of illegal dumping following the introduction of a DVR scheme. Important as the attempt was, it does not provide a robust estimate for the locality concerned, let alone for other studies which have subsequently made use of the estimate (and indeed, the authors themselves are appropriately cautious concerning the accuracy of this result).

123. The study then examined the policy issues related to the scheme. In particular, it carried out a cost benefit analysis of the scheme. The approach undertaken was:

- Assuming the social marginal cost of refuse collection and disposal is \$1.03, the net social benefit of reducing the demand for garbage was estimated. This social benefit took into account only waste reduction which was legal. It did not include a social cost associated with clean-up;
- No benefits were attributed to additional recycling and composting;
- The benefit per household was converted to an equivalent administrative cost which constituted the break-even point for the scheme;

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and labour-intensive task. They also note, in a footnote, *'residents are not supposed to mix yard waste with regular garbage. Instead, Charlottesville conducts special collection of yard waste each year. Some households still included yard waste with garbage, however, and we took care to exclude it.'* It would clearly have been interesting if the authors had weighed the garden waste. Indeed, charging might have been expected to shift garden waste away from the garbage collection and into the special collections. Given these points, the quantified changes in behaviour are somewhat dependent upon the diligence of the separation of garden waste from garbage. There must also be questions raised as to whether the study was correct in assuming that what was happening in neighbouring authorities could not have happened in Charlottesville.

- This was then compared with an estimate of the administrative costs of the scheme.<sup>21</sup>

124. The results are shown in Table 3:

**Table 3. Cost-Benefit Comparison for Charlottesville, Virginia**

Assumption	Benefits (per person per year)	Threshold Administrative, Enforcement and Compliance Costs (per bag)	Estimated Administrative Costs to Government (per bag)
No minimum:			
<i>No dumping</i>	3.59	0.149	0.193
<i>DUMP1<sup>a</sup></i>	2.67	0.111	0.193
<i>DUMP2<sup>b</sup></i>	2.17	0.090	0.193
One-bag minimum			
<i>No dumping</i>	2.54	0.105	0.193
<i>DUMP1<sup>a</sup></i>	2.38	0.099	0.193
<i>DUMP2<sup>b</sup></i>	1.95	0.081	0.193

<sup>a</sup> Includes the missing garbage of households who used 'other' methods to reduce garbage and set out no garbage for collection following the implementation of unit pricing

<sup>b</sup> Includes the missing garbage of households who may or may not have used 'other' methods but who set out no garbage for collection following implementation

<sup>c</sup> Excludes enforcement costs to government and compliance costs to households

Source: Fullerton and Kinnaman (1996).

125. The conclusion – highlighted in Table 3 above - was that the social benefits were less than the additional administrative costs (in Table 3, the figures under column B are greater than those under column A). The analysis, however, was somewhat limited in that:

1. The social marginal costs of collection and disposal were taken from a study by Repetto *et al.* (1992) which may not reflect the costs, or potential range in such costs (a unique figure seems inappropriate for reasons discussed below);
2. On costs and benefits, there was no discussion of:
  - External benefits associated with any legitimate reduction in waste quantities;
  - External benefits associated with the shift from refuse collection to recycling. A number of studies report quite significant external benefits associated with recycling, though this always varies by material;<sup>22</sup> and
  - External costs associated with any increases in illegal dumping (the report makes this clear).

Hence, environmental costs and benefits were far from completely captured;<sup>23</sup>

21. Some of these appear unnecessarily high. It was suggested, for example, that each sticker (to place on a refuse sack) would cost \$0.13. Printing sacks with the logo of the authority on the sack would, today, cost around \$0.05 per sack (negating the need for separate tags, and so reducing the cost to the householder – there is no need to buy the sack *and* the tag).

22. See, for example, Nolan-ITU *et al.* (2001); Hogg *et al.* (2000), ECOTEC and CSERGE (1999), Coopers & Lybrand, CSERGE and EFTEC (1997); Brisson and Powell (1995), Powell, Pearce and Brisson (1995) and Powell, Craighill, Parfitt and Turner (1996).

23. This is a surprisingly common error. The same is true, for example, of a recent paper by the late (and widely lamented) Professor Pearce which purported to cast a shadow over the waste management hierarchy (Pearce, 2005). Pearce's analysis of the UK system of packaging recovery simply omitted to

3. The only effects on the authority's costs were assumed to be the increase in administrative costs associated with buying and distributing bags. In addition to these, one might expect that:
  - a) The reduction in the number of bags collected per household might be expected to reduce the costs of waste collection, subject to a range of caveats about how this reduction is achieved;
  - b) Equally, the increase in recycling might be expected to change the costs of the recycling collection, though exactly how depends upon the nature of the additional materials collected, etc.;
  - c) Finally, the additional (incremental – i.e. above the costs of conventional refuse collection and disposal) costs of clean-up of any increase in illegal dumping ought to be considered.

Hence, the effects on the private costs of the waste management system were not considered in their entirety;

4. Costs associated with the input of time by households (the report identified this as an omission – see also Section A.2.1 below).

126. The study did look at the sensitivity of the cost-benefit equation to the level of illegal dumping concerned. This did not affect the general conclusion drawn, though it did affect the break-even point, effectively setting the maximum level of administrative costs which would still give rise to net benefits. The study itself concludes:

*Many in Charlottesville were already participating in the voluntary recycling program before unit pricing began. Thus the incremental benefit of unit pricing is small. In our simple comparison, this social benefit does not cover the administrative cost.*

127. As indicated above, this may simply be because the benefits were not fully evaluated. Given the limitations of the study in respect of assessing the net costs and benefits of such policies, the most important issue to which the study draws attention is the need for an assessment of the net costs and benefits of charging systems to consider the potential for increases in dumping as a result of the policy. As we shall see, this is far from straightforward to do.

### **A.1.2 Dijkgraaf and Gradus**

128. Dijkgraaf and Gradus attempted a more extensive cost-benefit analysis of DVR charging systems.<sup>24</sup> In the study, they note:

*From a welfare point of view a number of effects are important with respect to the evaluation of unit-based pricing systems:*

1. *The change in collection costs due to the effect on the collected quantity.*
2. *The change in treatment costs due to the effect on the collected quantity.*
3. *The change in administrative costs due to the introduction and maintenance of the unit-based pricing system.*
4. *The social costs of extra illegal dumping due to the introduction of unit-based pricing system.*

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attribute any social benefits to recycling, thereby effectively only considering private costs as opposed to all social costs and benefits. It goes without saying that initiatives which promote recycling – whether they be the provision of new services, or incentives designed to encourage the use of these services – are unlikely to fare well in a cost benefit test if one assesses only their costs and none of their benefits.

24. Dijkgraaf and Gradus (2003) and (2004) (The former paper is somewhat more extensive in its treatment.)

[...] As we are interested in the welfare effects of the different systems not only the out of pocket costs (private costs) are important, but also the effects on the environment of collection and treatment.

129. The system examined was based entirely on bring sites where the collection of dry recyclables (GPT, or glass, paper and textiles) was concerned. A door-to-door collection for refuse and for VFG (vegetable, fruit and garden) waste was in place.

130. The environmental costs of transport associated with the GPT system was taken to be zero (see Table 4). This would generally be disputed unless it could be shown that there was no use of vehicles specifically related to taking materials to bring banks (and this is, of course, possible if the network of banks is so dense that one could safely assume all visits were related to routine walks, or even drives, past the containers). On the other hand, in most EU countries, fuel is taxed at levels which almost certainly internalize a significant proportion of the external costs of transport. Hence, it may be reasonable to argue that the external costs of transport have been internalised, and that citizens take this into account in considering the implications for them of their actions.<sup>25</sup> However, the time devoted by citizens to the issue is an issue worthy of further discussion, especially where the collection system for dry recyclables is not based around door-to-door collection (or kerbside schemes) (see Section A.2.1).

**Table 4. Social costs of collection and treatment**  
€ per tonne

	<b>Solid</b>	<b>VFG<sup>1</sup></b>	<b>GPT<sup>2</sup></b>
<b>Private collection costs</b>	41	41	5
<b>Private transport costs</b>	30	30	30
<b>Private treatment costs</b>	91	49	-53
<b>Total private costs</b>	162	120	-18
<b>Environmental collection costs</b>	0	0	0
<b>Environmental transport costs</b>	1	0	0
<b>Environmental treatment costs</b>	18	9	-173
<b>Total environmental costs</b>	19	10	-173
<b>Total social costs</b>	180	129	-191

<sup>1</sup> Vegetable, fruit and garden waste

<sup>2</sup> Glass, paper and textiles

Source: Dijkgraaf and Gradus (2003).

131. The study took estimates of external costs and benefits from EU and UK data. For incineration, an external cost of €9 per tonne was assumed. For composting, the estimated value was €0 per tonne. The estimates for incineration and composting supposedly came from a study by Brisson, though we could not find estimates for composting in that work).<sup>26</sup>

132. The figures for external benefits of recycling were taken from the regulatory impact assessment cited in the UK's Waste Strategy. These were, in turn, based upon the work of Coopers and Lybrand et al (1997), adjusted for inflation and exchange rates. The Coopers and Lybrand estimates were based upon

25. In one EU study, a similar argument was used as a basis for ignoring the transport related externalities associated with waste collection. The argument ran that since quoted private costs include the cost of fuel, including taxes, then the external costs would effectively be internalised in private costs. The study carried out an analysis showing that in EU Member States, the level of duty at which this assumption would hold good was at a level lying between the prevailing highest and lowest levels of duty (see Eunomia *et al.* (2002)).

26. See Brisson (1997). It should be noted that there are a number of methodological assumptions which affect the outcomes of any analysis of private and external costs. It is important, therefore, when using results from one or other study to ensure that these are consistent across the sources used (or to ensure that they are made so through appropriate adjustments).

assessment of externalities associated with a narrow range of pollutants. They also incorporated the external costs of transport associated with a kerbside collection of recyclables (so other things being equal, the study probably understates the external benefits from recycling since it effectively internalises transport externalities as though a door-to-door system was in place).

133. An important feature of the study was the attempt to model different DVR charging systems. Much of the work undertaken in the US has concentrated on those systems of which there has been greatest experience, namely, pay-per-bag systems and subscription systems based on container volume. It is probably true to say that EU countries have rather more by way of experience with weight-based systems and other systems based upon electronic identification (tagging of bags or chipping of bins) to record collection frequencies / numbers of bags collected during the collection round.

134. The results of the analysis are shown in Table 4. One assumes that the presentation is based upon costs per household (the study is not absolutely clear on this). Some of the observations regarding net costs and benefits are important, not least since they suggest that the omissions in approaches such as that of Fullerton and Kinnaman – which take into account a limited range of benefits – are potentially significant:

*It should be noticed that the weight-based and the bag-based system decrease the amount of solid waste with large environmental costs substantially and increase the amount of recyclable waste with high environmental benefits also substantially. From the view of private costs the weight-based system performs better than the other systems. The reason for this is the higher savings on collected waste. Therefore, in social terms the weight-based system performs slightly better than the bag-based system.<sup>27</sup>*

135. In a subsequent paper, the authors appear to have revised their views somewhat. They conclude:

*We find that the weight- and bag-based pricing systems perform far better than the frequency- and volume-based pricing systems. The bag-based system seems to be the best option, as its effects are comparable to those of the weight-based system and yet its administrative costs are far lower.<sup>28</sup>*

136. The principle reason for this appears to be appreciation of the administrative costs of running the schemes. The later study suggests these are €6.86 per inhabitant for a weight-based scheme and €3.18 for a bag-based scheme.<sup>29</sup>

**Table 5. Costs under flat rate fees and changes in costs under different charging schemes**  
€ per household

Costs	Flat rate (level)	Weight (change)	Bag (change)	Vol. and Freq. (change)	Volume (change)
<b>Total private costs</b>	45	-14	-12	-6	+1
<b>Total environmental costs</b>	-12	-6	-6	-3	-0
<b>Total social costs</b>	33	-20	-18	-9	+0

Source: Dijkgraaf and Gradus (2003).

137. There was no explicit attempt in the assessment of costs and benefits to understand the possible implications of illegal dumping, which the earlier study of Dijkgraaf and Gradus suggests may be an important element in the overall analysis of social costs and benefits. Instead, the authors assess the effects of varying the social costs of illegal dumping on the net benefits of the DVR charging system.

27. Dijkgraaf and Gradus (2003).

28. Dijkgraaf and Gradus (2004).

29. These figures are taken from VROM (1997).

Effectively, they demonstrate where the social costs would have to lie in order for the DVR charging system to ‘break even’ in terms of costs and benefits. They conclude:

*It seems reasonable to assume that the social valuation of illegal dumping is above the level of 180 euro per ton. However, the shadow price of illegal dumping should be raised almost four times for the flat rate to perform better than the weight-based system. Therefore, from a social point of view there seems room for further implementation of weight-based or bag-based pricing systems. If the shadow price of illegal dumping is approximately 750 euro, social costs are equal for both systems. In this case the bag and volume and frequency system still produce social benefits. However, when the shadow price is more than 1072 euro, which can be interpreted as extreme dislike of society for illegal dumping, the flat rate system is preferred above all other systems.<sup>30</sup>*

138. In their later work, they suggest that although more investigation is merited, and whilst preventative measures and sanctions should be considered, dumping does not appear to be the primary explanation behind waste reduction under charging schemes:

*In general, the high population density of The Netherlands would suggest a low level of illegal dumping compared with other countries. This is confirmed by the lack of clear anecdotal evidence despite the large number of municipalities with unit-based pricing. However, as the main disadvantage of unit-based pricing systems is the potential effect on illegal dumping, it seems worthwhile investigating an effective monitoring and fining system and the conditions under which such a system would work.....*

*... Given the high population density of The Netherlands and the lack of anecdotal evidence, it seems implausible that a large part of the reduction in unsorted waste is due to illegal dumping.<sup>31</sup>*

139. The work of Dijkgraaf and Gradus is completely different in its approach to that of Fullerton and Kinnaman. The former tries to understand the private and external costs of the changes occasioned by introducing DVR charging systems, the latter concentrates on the elimination of what economists refer to as deadweight losses associated with refuse collection, and the potential impact of the system on illegal dumping. Unsurprisingly, perhaps, the studies reach radically different conclusions.

### **A.1.3 Skumatz**

140. Another attempt to understand the costs and benefits of unit pricing systems is that of Skumatz (2002). Skumatz’s analysis can be more accurately described as a cost effectiveness analysis. The analysis does not include assessment of external costs. It seeks to illustrate the ratio of benefits, in terms of avoided costs of landfilling, relative to costs of scheme implementation.

141. However, it is not clear from Skumatz’s analysis whether or not the scheme costs being quoted already account for the avoided costs of landfilling in their reporting. It seems reasonable to suggest that double-counting is occurring simply because some of the systems mentioned report a reduction in costs, which would only be possible if the avoided costs associated with waste reduction (avoided landfill costs) were already factored in. If this is true, then the benefits of charging systems have been overstated (since they are already factored into the system costs).

### **A.1.4 Eunomia**

142. Eunomia (2003) also made an attempt to model the costs and benefits of different unit pricing systems. This was part of larger body of work seeking to understand the merits or otherwise of introducing such systems into the UK, where the legislation currently mitigates against the use of such

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30. Dijkgraaf and Gradus (2003).

31. Dijkgraaf and Gradus (2004).

systems. As such, the modelling of costs and benefits was based upon estimates of the potential impact of schemes operating under UK conditions, reflecting research carried out in other countries. All of the modelling assumed the presence of kerbside collections of dry recyclables and compostable materials.

143. In the study, the costs of different waste management systems were modelled taking into account changes in the quantity of material collected through different routes, and the costs of treatment of the material. Reflecting the UK situation (in which the landfill tax for municipal waste is set to rise over forthcoming years from £18 per tonne in 2005 to £35 per tonne by 2012 at the latest), costs were also modelled using different costs for dealing with residual waste. It is important to note that the study was concerned principally with the costs to local authorities, and the associated environmental benefits. Part of the intention was to demonstrate how the situation for local authorities would change as a consequence of increased disposal costs, including landfill taxes.

144. The study:

- Used a figure for external benefits of recycling dry recyclables of £100 per tonne, noting that these vary across studies, and reflecting a typical basket of recyclables in the UK (which is usually around 60-65% paper, 30-35% glass, with the balance being steel, aluminium, textiles and plastics, the proportions depending on the collection system used). The study noted that ideally, studies seeking to assess benefits of additional recycling attributed to unit pricing schemes should look at the nature of the additional material collected (since the external benefits vary significantly across the materials). As with the study by Dijkgraaf and Gradus, the study concentrated on *additional* material recycled;
- Used a figure of £1.50 per tonne for the net external benefits of switching from disposal to composting reflecting earlier work carried out for the European Commission;<sup>32</sup>
- Attributed benefits to waste avoidance in line with the estimates from the PEEPs Report for the European Commission, which estimated a benefit of €300 for avoided compostable waste, and €380 for avoided recyclable waste.<sup>33</sup> The study assumed a figure of €90 for all waste avoided;
- In addition, because source reduction in many schemes was deemed likely to be due primarily to increases in home composting, low and high figures for the associated benefits were calculated on the basis that 20% and 100%, respectively, of the source reduction could deliver the suggested benefit of €90 per tonne;
- Did not consider any external costs associated with dumping;
- Did not consider household time in calculating private costs.

145. The results derived from the study are shown below. Table 6 shows that where disposal costs are low, and where 30% of UK households are involved in DVR schemes, for a net cost of just under €21 million, benefits of €163-462 million are generated. This is associated with an increase in the national recycling rate from 32% to 37%, and a reduction in residual waste of 7% from the pre-scheme level. The implied benefit cost ratio is between 8:1 and 22:1. At higher disposal costs, representing the situation the UK will reach in 2012, or before, as a consequence of increase in landfill tax, the benefit cost ratio can become negative (since the net costs fall below zero). In this case, the net costs are negative, whilst the same benefits of €462 million are generated. The benefit cost ratio loses much of its meaning because of this net reduction in costs.

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32. This is the UK figure taken from Hogg *et al.* (2002).

33. RIVM, EFTEC, NTUA and IIASA with TME and TNO (2000).

Table 6. Summary costs and benefits of implementing DVR schemes in the UK

Scenario	Net Financial Costs (€mn)	Net Environmental Benefits (€mn)	
		Low	High
30% Coverage, Disposal Costs €44/tonne	€20.71	€163	€462
30% Coverage, Disposal Costs €72/tonne	-€30.10	€163	€462
70% Coverage, Disposal Costs €72/tonne	-€63.71	€374	€1,048

Source: Eunomia (2003).

146. The study also modelled situations where 70% of UK households were covered by such schemes. At 70% coverage, the benefits were estimated to be in the range €374-1,048 million. Residual waste requiring disposal falls by almost 6 million tonnes, or 16% of the total quantity of waste.

147. As with the study by Dijkgraaf and Gradus, therefore, the study indicated significant net benefits associated with unit pricing systems. However, as mentioned above, the study took no account of the potential private and external costs of illegal dumping. Nor was any attempt made to account for additional time spent by householders in sorting activity. The study noted the somewhat exploratory nature of the analysis undertaken:

*Of course, the modelling as carried out here is somewhat speculative. It makes certain assumptions concerning behavioural change which might not be borne out in practice. Indeed, as we have suggested elsewhere, responses are strongly conditioned by the ability of householders to respond in terms of source separation and opportunities for waste reduction. However, these figures are indicative of what is achieved in systems examined in this report.*

148. The study also showed that the net private costs of implementing charging systems fall as the costs of treating or disposing of residual waste (i.e., the unit costs for sending waste to a residual waste treatment facility) rise. This is because one of the effects of charging systems tends to be to increase the proportion materials collected as dry recyclables and compostables. Consequently, if there is no source reduction, the costs of the waste management system will increase if the cost of collecting materials for recycling and composting is greater than the costs of collecting material and subsequently disposing of it. Where disposal costs are higher, there are more likely to be net savings to the municipality from collecting less of the waste as residual waste and more as recyclables / compostables.

149. Indeed, assuming a given response associated with a charging system of a given private cost, one could postulate the existence of a 'threshold' at which the net private costs turn negative. This is important since it suggests that the internalisation of negative externalities of disposal, or regulatory activity which makes disposal technologies more expensive, will tend to make a local authority more positively disposed to implementing kerbside collection schemes, and to implementing variable charging systems. As the study noted:

*Where DVR schemes are concerned, higher disposal costs are not so much necessary as desirable, since they accentuate the benefits of the avoided disposal costs occasioned by the increases in source separation and the source reduction driven by the charging scheme. At a £35 landfill tax, the DVR schemes begin to look much more cost-effective. The higher avoided disposal costs make the logic of such systems even more compelling.*

150. Finally, the study played strongly on the desirability of introducing DVR schemes against the backdrop of quality and convenient kerbside collection services. These are generally thought to be, if not necessary, then important in limiting the degree to which illegal evasion of the charges occurs through dumping etc:

*It is important to bear in mind, whilst considering the nature of any DVR scheme, that the most important aspect of any waste management scheme is not the charging system, but the integration of all aspects of the system. Hence, there can be no substitute for careful consideration of the collection system itself. Our study has investigated a number of cases where source separation rates approach, or exceed, 60% (Gent, Comuni de Navigli, Treviso, Landkreis Schweinfurt, Nijmegen). Sadly, very few municipalities in the UK have systems in place today which could aspire to such levels of source separation. This suggests that few local authorities in the UK today could introduce DVR schemes without having to confront issues associated with evasion of the variable element of the charge. However, there is no reason why DVR systems should not be implemented swiftly after comprehensive collection schemes are in place, or indeed, at the same time as the collection system changes [our emphasis].*

## ANNEX 2: KEY METHODOLOGICAL ISSUES

151. Two interesting methodological issues arising from the review of literature are those associated with whether or not to include householders' time (and if so, how?), and the degree to which charging leads to problems of contamination of separately collected fractions (waste leakage).

### A.2.1 The issue of householders' time

152. None of the studies considered in Annex 1 attributed any cost to the time taken by householders to cope with waste management systems, though Fullerton and Kinnaman (1996) raise this as an issue. Some cost-benefit studies unrelated to charging systems – among them, those of Radetzki, Bruvoll and Sterner and Bartelings<sup>34</sup> – seek to impute a cost associated with time involved in waste-related activity in the household.

153. Where this does occur, then to the extent that one seeks to understand the costs and benefits of a charging scheme, it should, of course, be the case that a charging scheme is only implicated in the 'incremental cost' of the time and resources spent by the householder above and beyond what was already happening in the absence of charging.

#### A.2.1.1 On time inputs, convenience and the propensity to dispose illegally

154. Radetzki (2000) imputes a cost calculated at the hourly rate paid to untaxed manpower for household services at around \$7.5 per hour (in 2000), equivalent to approximately €8.40 per hour in 2005. Even if one assumes such costs should be identified, this level might be questioned. Markandya, for example, valued non-working time at 15% of the gross wage rate (though the basis for the figure is not made clear in the context).<sup>35</sup> Bartelings (2003) uses these other studies as a basis for making assumptions concerning the costs of separation of organic wastes.

155. Relatively little attention is given by any of these authors as to the effect of the nature of the service provided to householders on the time spent dealing with waste. The estimates of time input from studies such as those by Bruvoll *et al.* do not sit easily alongside much of the discussion of charging systems for the reason that the systems are (by inference) incredibly inconvenient (9 hrs per year transport to collection points) and would be awkward systems against which to apply charging schemes.<sup>36</sup> Where the collection of recyclables is exclusively through bring schemes, a general cost-benefit analysis ought to account for the fact that the unit costs of recycling for the municipality would (or should) be correspondingly low since much of the increase in costs will be borne by the householders themselves. Systems which are inconvenient are also far more likely to engender illicit behaviour on the part of

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34. Radetzki (2000), Bruvoll (1998) and Sterner and Bartelings (1999).

35. Markandya (1998), cited in RPA (Risk and Policy Analysts) and *Metroeconomica* (1999).

36. See Bruvoll, Halvorsen and Nyborg (2000) and Bruvoll, Halvorsen and Nyborg (2002). It is a feature of some Scandinavian collection systems that greater reliance is placed upon bring recycling centres than on kerbside collection of recyclable materials. This could be compared with, for example, Germany, Austria, Belgium, Italy, United Kingdom, or Australia, etc. where rather greater emphasis is placed upon doorstep recycling.

householders since reducing exposure to the charge through legitimate means is, by definition, more difficult and time consuming (and may be more so the more distant the household is from bring sites and container-parks).

156. Generally, one might consider, therefore, two ends of a spectrum for local authorities implementing charging schemes. To stylise these systems somewhat, these would be:

- Those which implement inconvenient recycling systems which impose time costs, and for that reason, will tend to deliver relatively low captures of material, and will be more likely to lead to problems of evasion; or
- Those which implement convenient, quality services with wide materials coverage, which impose little or no additional time cost (the household simply uses the right container, although some additional washing may be required for some containers) and deliver higher captures of recyclable material as well as less by way of illegal dumping. These services, at least from the perspective of collection alone, are, usually, more expensive at the point of delivery. However, the net system costs are also heavily influenced by the costs of disposal being avoided, so where collection systems are well-designed, increased collection of recyclables can lead to net savings owing to reduction in the costs of collection of refuse and its treatment / disposal.

157. In other words, if one is considering *convenient*, high-quality kerbside schemes, making use of estimates for time cost derived from studies focusing on *less convenient* bring systems is likely to be a mistake. This is the first reason why focusing heavily on time in the context of DVR charging schemes might not be relevant, unless the scheme is inconvenient, in which case, issues of dumping will probably also arise. It is generally recommended that charging systems, because of the potential incentive they generate to dump illegally (the significance of which is contested in the literature, apparently less so in practice), should be introduced only where good quality recycling infrastructure is already in place.<sup>37</sup>

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37. It is, in our view, surprising that studies of charging systems do not spend more time describing the available waste management infrastructure in more detail. Most waste practitioners take it as understood that introducing DVR charging systems against the backdrop of poor infrastructure for segregated collection (not just at the kerbside) is tantamount to inviting a greater problem of dumping than would otherwise arise. The opportunities to respond positively (and legally) to the incentive ought to be made available to those targeted by the incentive. The literature on dumping is primarily based upon indirect observations. One of the most oft-cited examples of any empirical research on this – that of Fullerton and Kinnaman (1996) discussed in Annex 1 – is based upon inferences (rather than direct evidence) from responses derived from 7 citizens. This may or may not be representative of Charlottesville, Virginia, and, one has to be careful to add, the type of system used there (*i.e.* not just the charging structure, but the associated waste management infrastructure, which conditions the nature of responses which might be available to householders, legal and otherwise). It is, in our view, entirely erroneous to extrapolate any result, however accurate or robust in a given local context, to places with differing charging structures, different levels of provision of waste management infrastructure and (possibly) differing propensities for commercial waste to enter the municipal system (which is almost certainly one mechanism through which waste is reduced when charging systems are introduced – the commercial waste moves back into the commercial waste stream). The example of South Korea – which we look at later – is clearly one where dumping has been raised as an issue. If dumping was a major problem, charging systems would probably be introduced and then terminated, precisely because of the problem, not least since responsibility for clear-up rests, in many jurisdictions, with the same entity responsible for providing the waste collection service. In these circumstances, the costs of dealing with fly-tipped waste would be a significant burden since clearing illegally dumped waste is not cheap (it is one of the most expensive ways to collect waste).

### A.2.1.2 Potential private gains in utility

158. Regarding household costs, Porter (2005) takes the view that the benefits which people may derive from participating in recycling are likely to be roughly equal to the social costs of engaging in the activity. He makes the point that some detractors of recycling have derived large costs for this activity. On the other hand, he adds that a positive willingness to pay for recycling is often identified in the literature.<sup>38</sup>

159. For Smith (2005), the issue as to whether or not additional time spent in recycling should be included in an analysis of costs and benefits of extended producer responsibility turns on whether the engagement with the activity is voluntary or enforced:

*However, household time and household direct expenditures on cleaning, sorting and transporting waste products should not be included in an assessment of the overall costs and benefits of EPR [extended producer responsibility], where households undertake these actions on a voluntary basis. Where household costs are incurred voluntarily, the inference might be drawn that the household experiences counterpart benefits, in the form of satisfaction – or a “warm glow” – from their environmentally-responsible behaviour, that are at least as large as any costs incurred. If this view is taken, then the costs incurred voluntarily by households should be omitted, so long as the “warm glow” benefits too are omitted. The implication is that, in the case of an EPR programme where households voluntarily choose to participate (and where they can, instead, choose to discard their waste in other ways), there is no need to include any estimate of household costs in the cost-benefit analysis of the programme.*

*On the other hand, there is a case for including at least some measure of household costs, where households do not incur these costs voluntarily. Where households are compelled by law to separate their wastes, or are required to transport their wastes to inconveniently-located collection facilities, some, at least, may perceive this as an onerous task, from which they gain no corresponding “warm glow”. Others may be happy to do this without compulsion, and may perceive no cost. It is then a matter, in principle, for research to determine what proportion of the population perceive the programme as imposing onerous requirements, and how large the perceived costs of the programme are to these individuals. The only household costs that should be included in the analysis are those borne by households who would not act in the absence of compulsion.*

160. Following this line of argument, then since DVR charging schemes do not *compel* households to segregate materials, one might be inclined to the view that time devoted to the activity should not be included as a cost.

161. On the other hand, the nature of incentives under DVR schemes is such as to alter the level of effort, and associated time input, related to household recycling. Consequently, the way in which additional recycling / waste reduction efforts associated with charging systems should be treated is probably through seeking to:

1. identify the incremental change in costs of time devoted to the activity;

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38. For example, Jakus *et al.* (1996) carried out studies to elicit willingness to pay for recycling, and estimated this at £5.78 per household per month, whilst Tiller *et al.* (1997) report that in Tennessee, households would pay \$4 per month (on the basis of contingent valuation). In seeking to understand some measure of the value of household time used in separation activity, Bruvoll, Halvorsen and Nyborg (2002) report that people in Norway on average would be willing to pay a significant amount for *others* to do the recycling as long as the same environmental benefits result. The study finds that some households would not wish to see this happen even when it is free (suggesting they themselves gain some benefit from the activity) whilst others would be willing to pay for the activity to occur even though it was offered at zero cost. This is interpreted by the authors as a basis for estimating the cost of householders' time but other interpretations clearly exist, not least of which is that this is a measure of the value of the activity of 'recycling', irrespective of who it is done by.

2. identify the utility derived by those engaging in the activity; and
3. quantify the net effect in terms of cost and benefit.

162. It is a somewhat open question as to what the net outcome might be. Such an analysis is far from straightforward to carry out. In cases where time costs are included, there is clearly a danger that no counterpart benefit is acknowledged.

163. Many households opt-in to recycling schemes without the need for any financial incentive. Presumably, therefore, where citizens alter their behaviour in response to the charge, they do so quite wittingly in the context of their own cost-benefit calculus.<sup>39</sup>

164. It remains the case that the nature of service provision can do much to reduce the effort required by householders, and reduce the requirement for space in households where this is a constraint (for example, by raising collection frequencies and providing appropriate means of containment). Cost-effective waste management is not simply about incentives to alter household behaviour. It is also about careful design of collection systems to ensure efficient capture of quality materials. Evidently, the private costs of the waste management system must remain a consideration for those with the responsibility for providing such a service.

#### ***A.2.1.3 Establishing norms of behaviour***

165. From a more institutionally informed perspective, one might argue that charging systems seek to establish, or strengthen, a norm of behaviour in which materials which can be recycled are recycled using the services provided. In the extreme, some municipalities have sought to effectively enshrine a rights structure which makes it a duty for citizens to segregate some materials. Through changing the rights structure, what is defined as the acceptable norm is transformed. Elsewhere, such formal sanctions may not be necessary as norms of behaviour change, in which case, the same effect can occur through the medium of informal institutional changes. In some studies, households have thought they were operating under a mechanism of compulsion when in fact, they were not.<sup>40</sup>

166. Under either circumstance, the fact that separating wastes becomes, either formally or informally, a duty (dependent upon the rights structure) makes it somewhat awkward to impute a labour cost element for the activity. At the same time, those designing recycling schemes (or for that matter any scheme which seeks to elicit public participation, for example, responsible handling of litter) must make the process easy for the public to participate in.

#### ***A.2.1.4 Waste leakage***

167. This final point is also relevant to the discussion from Bartelings (2003) concerning what she describes as waste leakage. Some modelling from Bartelings - which does not appear to be based upon empirical research, but upon somewhat subjectively chosen variables - suggested that charging systems can lead to households increasing the amount of mixed residual waste placed in those containers for which no charge is paid. She effectively assumes that collected waste for composting is thereby rendered

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39. One study has even suggested that introducing charging systems can dissuade *some* households from recycling as they 're-frame' their decisions. In other words, some households may switch between voluntaristic pro-social behaviour to a more 'hard-headed' calculus of costs and benefits in the wake of the introduction of charging schemes, leading them to reduce (or sometimes stop) recycling activity (see Thorgersen (1994)).

40. See Bruvoll, Halvorsen and Nyborg (2000) and Eunomia (2004b).

difficult to compost because of the low quality of the material received (because it is assumed to become contaminated).

168. The point is an interesting one, but once again, this can be addressed through design of the collection system. It is an outcome neither of ‘a DVR charging system’, nor of ‘a service configuration’, but rather, the interaction between the two. For example, Italian systems which target food waste (often in the context of DVR charging systems, now being mandated across Italy) – according to the available figures – show an extremely high purity for collected material where the collection is frequent and made at the doorstep (i.e. convenient). One of the reasons is that the chosen method for collection – the use of translucent starch-based biobags – allows for a ready check on the purity of the material. Since targeting food wastes is also one of the most cost-effective approaches to collecting biowastes (because the high density of the material makes compaction mechanisms unnecessary and because it constrains the delivery of garden waste into the collection system<sup>41</sup>), such systems can be designed to collect biowaste at high frequencies whilst keeping costs down and purities up. The Tables below show that both in Italy (where DVR charging schemes are becoming widespread) and in Catalonia (where there has been only one experience – discussed in Annex 4 below) systems which capture biowastes very effectively can deliver high purity streams both in cases with and without charging in place.<sup>42</sup>

**Table 7. Specific capture and purity in schemes for source segregation of food waste in Catalonia**  
December 2002

DOORSTEP SCHEMES	Performances of schemes for food waste	
	Quantity (g / inhabitant per day)	Quality (% impurities by weight)
Tona (6.000 inhabitants)	309	3.5 %
Tiana (6.000 inhabitants)	309	6.6 %
Riudecanyes (750 inhabitants)	430	6.5 %
Balenyà (3.000 inhabitants)	283	3.5 %
Folgueroles (1.700 inhabitants)	408	2.7 %
Arenys de Munt (6.800 inhabitants)	358	--
Viladrau (900 inhabitants)	496	--
Calldetenes (2.000 inhabitants)	313	---
AVERAGE doorstep	363	4.6 %

Source: Favoino, Ricci and de Fontanals (2003).

169. In Veneto region (Italy) a survey by the Regional Environment Agency illustrates the difference in foodwaste contamination due to the use of compostable bags (in modified starch of MaterBi) and PE-bags in separate collection schemes for kitchen waste. Average results show non-compostable materials to be:<sup>43</sup>

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41. The reader is referred to a number of papers on the matter, including: Favoino, Ricci and de Fontanals (2003); Hogg *et al.* (2002) and Amlinger, Ricci, Favoino and Hogg (2004).
42. Bartellings (2003) defines low-quality compost as compost of greater than 30% impurities. This is a very high figure. Mixed municipal waste in most European countries contains around 65% or so of paper, card, food waste and garden waste, all of which are, in principle (and in the right proportions) compostable. To fall to levels of 30% purity would effectively demand that collectively, citizens put the majority of waste into the biowaste container. This, in turn, would imply almost no residual waste! Since one of the features of many charging systems (depending upon the design) is that they tend to generate information about householders’ waste management activities, it would be somewhat strange if this did not raise some concerns on the part of the service provider. Few people would be generating residual waste. This is another area where system design is as much responsible for any effect as the charging system itself – the two need ‘to fit’
43. See Environmental Protection Agency of Region Veneto (2004).

- 1.33% in weight, for schemes using compostable bags
- 4.45% in weight, for schemes adopting PE-bags

**Table 8. Purity of collected food waste**  
Assessed through sorting analysis

Municipality/Area	Inhabitants	Compostable materials ( per cent weight)
Lecco Province, 83 municipalities	313,884	99.5
Municipality Monza	119,187	97.4
District 'Padova 1', 26 municipalities	203,429	98.7
Municipality Nonantola	11,127	99.8

Source : Provincia di Milano (1998), Favoino (1999), Bigliardi (1998) and SILEA-IPLA (2002).

**Table 9. Purity of Collected Food Waste in Municipalities in Milan Province**

	Inhabitants	Compostable Materials (%) <sup>1</sup>
Varedo	12,720	99.7
Villasanta	12,446	99.7
Misinto	3,865	99.4
Castano Primo	9,652	99.3
Lainate	22,236	99.3
Desio	34,849	99.0
Albairate	3,808	98.9
Albate	4,713	98.8
Brugherio	30,800	98.8
Corbetta	13,516	98.8
Trucazzano	4,062	98.6
Bellusco	5,971	98.4
Cinisello Balsamo	75,650	98.2
Arese	19,230	98.1
Trezzo Sull'adda	11,177	98.1
Melegnano	16,112	98.0
Monza	119,187	97.4
Rosate	4,332	97.4
Buccinasco	23,890	96.5
Biassono	10,493	95.0
Novate Milanese	20,028	94.3
Paderno Dugnano	44,748	93.7
Cologno Monzese	50,121	93.0
<b>Weighted Average</b>	<b>553,606</b>	<b>97.2</b>

Source: Favoino, Ricci and de Fontanals (2003).

<sup>1</sup> Effectively, the level of impurities is given by 100% minus this figure.

170. Apart from making collection systems more convenient to householders, other ways of overcoming waste leakage have included:

- Using on-vehicle sort systems for collection of dry recyclables (where the materials are sorted as they are collected);<sup>44</sup>
- Using systems where dry recyclables are collected in ways which allow a visible check on purity (see-through sacks for packaging and bundled paper / card etc.);

44. Where materials are collected in this way, incorrectly separated dry recyclables would be rejected at the kerbside. The fact that such materials would be rejected continually would, most likely, make citizens realise that their behaviour would have to change, if indeed the point was not made to them explicitly (by collectors).

- Applying a charge to biowaste collection, but at a lower rate than for refuse (so that the differential between the refuse container and the biowaste container is not unduly large);<sup>45</sup> and
- Using a combination of variable and fixed charges so that marginal incentives are lower, and less likely to lead to dumping and / or cross contamination. This has the potential upside of improving revenue stability (for cost recovery) where the municipality is concerned.

171. All of these approaches are in operation. It is rare to achieve a 100% purity in the collection of separated fractions, but a system which works in the way implied by the modelling of Bartelings is almost certainly one that needs changing.

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45. This is becoming a common approach in Europe, not so much to address the issue of waste leakage as one to address the excessive delivery of garden waste into the collection system (implying increased collection and treatment costs), and the disincentive to home compost implied by providing garden waste collections at zero marginal cost. Waste leakage, therefore, may be more a problem in the context of dry recyclables collections, especially where these are provided at zero marginal cost, as they are in many systems where charging is applied (not least in those where producer responsibility systems effectively pay for the complete cost of the service). The costs of subsequent management of this leakage would, of course, be reflected in the costs to producers, and hence, in product prices.

### ANNEX 3: PRIVATE AND EXTERNAL COSTS OF WASTE MANAGEMENT OPTIONS

#### A.3.1 Issues pertaining to the financial costs of waste collection

172. Waste management systems are complex. They do not lend themselves especially readily to a straightforward characterisation of costs and benefits. It is the system nature of waste collection and treatment systems which frequently trips up the unsuspecting analyst.

173. When assessing the net social (i.e. financial and environmental) costs and benefits of waste management systems, it is tempting for analysts to believe that the environmental costs are what is less well understood, and that the reported financial costs of managing waste are well understood. Yet experience in the field of municipal waste management suggests a number of things regarding the financial costs reported:

- Generally, the costs reported by municipalities for the management of waste vary significantly.<sup>46</sup> They vary for a range of reasons, but one of them is simply the incredible variety of ways in which the costs are accounted for, a matter complicated by the fact that the municipality may or may not own some of the assets which are deployed in the delivery of services. Consequently, great care has to be taken when considering reported costs of municipal waste management;
- The financial costs of collection systems are actually rather poorly understood (both by most municipalities and by many analysts, particularly those engaged in analyses of costs and benefits). Typically, there is a lack of appreciation of waste management services as systems. Consequently, where those managing services are concerned, collection systems do not always reflect the best approach to balancing performance and cost. Also, where analysts seek to understand an optimal approach, the basic fact that the costs of waste management systems are poorly understood tends to lead to oversimplification of the analysis;
- The economic analysis of separate collection systems (i.e. collection systems for recycling and composting) frequently assumes that the marginal cost curve is an increasing function of the quantity collected. Actually, the situation in a given municipality is far less straightforward than this simple assumption would suggest. For example, viewed from the point of view of the separate collection system, then if more material is captured from the same number of households in constant proportions, economies of scale in that collection system result, and the average cost per unit collected falls. Essentially, whether the marginal cost of a separate collection system rises or falls depends upon a number of factors:
  - How the additional material is being acquired:
    - \* Is it through adding new materials to the collection scheme (if so, which, and how?)?
    - \* Is it through expanding the scheme to new households (if so, which type, where, and how?)?
    - \* Is it through enhanced recognition of specific materials (if so, which ones, and how does this affect the relative proportion of materials collected)?

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46. See Eunomia (2002).

- \* Is it through enhanced participation in the scheme (if so, do the new participants display a high level of recognition (lower cost) or a lower level (higher cost))?
- Where several materials are being collected at the same time, whether the relative proportions of material collected shift in favour of materials with a higher (lower cost) or lower (higher cost) bulk density;
- Whether collection frequencies stay the same or change.

174. This is not an exhaustive list by any means. It does highlight, however, the crudeness of any model which assumes, for nothing other than convenience and convention (since it can lead to conclusions which are incorrect), that the marginal costs of separate collections (for recycling and composting / anaerobic digestion) always increase with the amount of material captured.

175. The picture becomes more complicated still once one begins to consider the potential to adjust the frequencies at which different fractions of the waste stream – refuse (or, as it will be referred to more often, residual waste), dry recyclables (and there may be more than one collection for dry recyclables, these potentially being collected at different frequencies), and biowastes (for composting or anaerobic digestion) – are collected. Local authorities use two approaches to influence the frequency of collection of different materials:

1. They set fixed frequencies of service (and seek to size containers accordingly, or they charge on the basis of container size); or
2. They have a maximum frequency of collection, but also have charging systems which reflect the frequency of collection (so households can choose to set out containers at frequencies below the maximum).

176. In considering collection frequencies, local authorities have to (or at least, they should) consider:

1. The nature of the materials being collected (for example, how, and at what frequency, will the most putrescible fraction – food waste – be collected). This is especially important in countries where the climate is relatively hot (either throughout the year, or for part of it);
2. The way in which the different frequencies of, and charges for, collection of different components of the waste stream are likely to affect the potential for contamination of fractions being separately collected for recycling or composting / digestion; and
3. The implications of the different collection frequencies for the required volume of the containers provided.

177. This last point is very important, and raises interesting questions where the collection of, for example, plastics is concerned.

178. The collection of plastics for recycling has often been questioned on cost-benefit grounds. Such analyses tend to focus on the net social costs of collection, including:

- Financial costs of collection;
- Environmental costs of transport; and
- Environmental benefits associated with recycling.

179. A key parameter is the financial costs of collection. It is often stated that it is expensive to collect plastics separately. Plastic containers:

- have a low bulk density;

- where they are collected in compactors, they do not compact especially well (because they have a highly elastic nature);
- consequently, they occupy a disproportionately large volume on vehicles relative to their weight; and
- they tend to arise in relatively small weights at each household.

180. How should the collection costs of plastic be understood given that they have to be collected either in refuse, or as part of a separate collection for recyclables? What are the implications of not collecting plastic bottles separately for:

- The volume of material to be collected as refuse?
- The minimum frequency of collection / container size required for refuse? and
- Consequently, the overall *system* costs of the collection system?

181. It is not correct to assume that the decision to include or exclude plastic in a separate collection scheme makes no difference to other aspects of scheme costs. The decision to exclude plastics may lead to, for example, a need for increased frequency of collection of refuse (at least, under some volume constraints), an increase in the number of vehicles required to deal with refuse (as well as a reduction in the number used to collect recyclables), higher costs for refuse collection, and potentially, *relatively* little change in the costs of the waste management system as measured in terms of the costs per household served. Any increased costs are likely to relate principally to the costs of sortation, net of revenues received.

182. Because waste management systems are *systems*, it makes little sense to speak only in terms of costs per tonne of a specific material collected. The overall system cost is likely to be revealed more closely through an analysis of the costs of serving each household as opposed to the costs of picking up a tonne of waste (which can be highly misleading given the potential for reductions in, for example, the frequency of refuse collection to reduce system costs). This, when combined with the costs of treatment, is also the most pertinent figure from the perspective of most municipalities. Per tonne costs are also misleading for another reason. By this measure, a municipality could claim to have an efficient refuse collection if it has a low cost per tonne. Yet low costs per tonne may reflect a high quantity of refuse collected per household. Far from being an efficient collection of refuse, the low figure may simply reflect a failure to provide, or encourage and incentivise use of, waste reduction and recycling initiatives.

183. It should be recognised that the choice of collection system can also influence costs. In the United Kingdom and in North America, debates concerning the relative merits of so-called kerbside sort systems relative to those based on co-mingled collection of recyclables are common. The latter has a heavier reliance on capital, usually employing compaction vehicles and mechanical sortation, and usually requires more land. The former is more labour intense, with (little or) no compaction mechanism used on the vehicles, less reliance on sortation post-collection, and less requirement for land. These differences – the pros and cons of which are still debated in countries with relatively high (in global terms) labour costs – are likely to be more readily resolved in low labour cost countries.

### **A.3.2 Issues pertaining to the financial costs of waste treatments**

184. Evidently, as treatment costs for residual waste rise, so the separate collection of materials for recycling or composting or anaerobic digestion becomes increasingly attractive on financial grounds. The viability of recycling systems on financial grounds increases as the costs of disposal rises.

185. In determining the net costs of a waste management system, the financial costs of different waste treatment and disposal options are extremely important to understand. Once again, one finds considerable variation across and within countries reflecting a range of different variables. These include variables

specific to different treatments. The following discussion outlines some of the relevant issues to some of the main treatments.

#### **A.3.2.1 Landfills**

186. For landfills, key variables include:

1. Land acquisition costs (these vary according to the nature of acquisition, *i.e.* whether this is outright or through leasing);
2. Potential void space (scale);
3. Capital expenditure and development costs (affected by geology, regulations);
4. Operating costs;
5. Restoration (related to area rather than tonnage);
6. Aftercare costs (affected by legislation);
7. Gas collection / energy recovery (affected by regulations / nature of support for energy delivered).

187. Unit costs tend to be determined by fill rates and overall capacity – the higher both are, the lower will be the underlying costs. Over time, in many countries, the potential increases in cost associated with regulatory drivers (for example, extending the period over which aftercare must be funded) have tended to be offset by resort to larger sites.

#### **A.3.2.2 Incinerators**

188. For incinerators, unit prices depend on a range of issues:

1. Land acquisition costs;
2. Scale;
3. The nature of the required waste handling equipment;
4. The nature of flue gas cleaning technology, which will be determined by the applicable limit values for emissions to the atmosphere (and by the input waste). These can account for a significant proportion of the overall capital costs;
5. Project development costs, including planning issues (these may be very significant depending upon the nature of the planning regime);
6. The nature of any energy generation equipment (determined partly by legislation, partly by prices for electricity and heat);
7. The nature, and cost of, treatment of solid residues, including air pollution control residues (determined in the main by regulation);
8. Revenues from the sale of electricity / heat generated by the plant;
9. Costs / revenues from the sale of any metals extracted for recycling;
10. Costs / revenues associated with the use of bottom ash for purposes such as road surfacing / building blocks.

#### **A.3.2.3 Mechanical Biological Treatment (MBT)**

189. We use the term MBT to cover the range of configurations of facility which make use of a combination of mechanical treatments and biological treatments to derive a combination of:

- Recyclable materials;
- Biological residues (the use, or treatment of which is likely to vary depending upon locally applicable regulations)
- Solid residues for use as a fuel; and

- Residues for disposal.

190. Key cost variables will include:

- Land acquisition
- Project development
- Scale
- Complexity of separation equipment deployed (which is likely to reflect the background cost of disposal, as well as the objectives of the plant – larger scale plant may enable more complex separation to be applied at a given unit cost);
- The quantity of material entering the biological treatment phase and the nature of the biological treatment process (whether aerobic or anaerobic or both, the residence time for the material, etc.);
- The requirements for exhaust gas cleaning using scrubbers and biofilters (determined to some extent by legislation);
- The quantity of material extracted as refuse derived fuel (RDF), and hence the costs of either:
  - Treating the material in dedicated facilities, in which case, the costs of the facility will be affected by similar considerations to those discussed under ‘incineration’ above; or
  - Sending the material for use off site in e.g. cement kilns;
- Where energy is generated from biogas, the revenues from any sales of heat / electrical energy derived;
- Where recyclables are extracted, the revenues from any sales;
- For solid residues from biological treatment, the costs / revenues associated with the disposal / utilisation of residues (significantly determined by legislation, but also local conditions);
- For other solid residues, the costs of disposal / utilisation (determined by legislation).

#### **A.3.2.4 Summary**

191. The above is not an extensive treatment, either in terms of cost variables or in terms of the treatments available. We have concentrated on the ‘technical’ determinants of the financial costs of the treatments concerned rather than the financial variables themselves (such as interest rates, required rate-of-return, allocation of risk, etc.). It should be noted that issues such as ownership of the plant, the nature of contracts between a local authority and the operator, and the approach to financing the plant have a bearing upon questions concerning the apportionment of risk associated with a given development. As a result, the costs of developing and running a given facility may or may not include premia associated with covering specific project risks (which may or may not be covered by parties other than the developer).

192. It should also be noted that the financial costs frequently differ significantly from market price for the service being supplied owing to, for example, over-capacity from treatments with high unit capital costs. In such case, the market price for the service can be far lower than costs of supplying the service as calculated in standard financial models. Similarly, where supply of waste management services is limited, or where local / regional monopolies operate, operators may generate rents from their monopolistic or oligopolistic position.

193. As a consequence of all these factors, there is considerable variation in both the financial costs of different waste management options, and the prices for the services in the marketplace, both across and within countries. Also relevant in terms of costs and prices are fiscal instruments – notably landfill taxes - used by many countries to incorporate external costs of different waste management options.

### A.3.3 Issues pertaining to the external costs of waste management

194. There have been a considerable number of studies on the environmental costs and benefits of waste management options.<sup>47</sup> Some of the key points which arise from these are summarised below. In doing this, we have drawn together comments as they apply to the overall methodology, and as they apply to the specific treatments examined:

#### A.3.3.1 Methodological issues

1. Most studies seem to use an approach based upon the use of unit damage costs to assess the harm caused by specific pollutants. Relatively few make use of 'bottom up' approaches in which the impact of emissions are modelled through dose-response functions applied to the locality in which an activity takes place.<sup>48</sup> In bottom up studies, clearly, the choice of dose-response function is important, as is the number of end-points selected for modelling through such functions. The state of scientific knowledge is changing over time so these choices are not as clear-cut as one might at first suppose. For some pollutants, does response functions may not be known with high levels of confidence. The choice in terms both of pollutants and end-points obviously has a bearing on outcomes in terms of the quantified environmental effects;
2. If the study is 'top down', the choice of unit damage costs becomes critical. Similarly, if the study is 'bottom up', the choice of dose response functions, the way the dispersion of pollutants is modelled, and the nature of the location assumed for any activity all become important. The scope of the analysis (the range of the pollutants modelled) is of obvious significance in both cases. There do appear to be some discernable trends in this regard:
  - a) The range of pollutants to which a damage cost is assigned appears to be expanding over time. Earlier studies tended to focus on emissions of GHGs, NO<sub>x</sub>, PM and SO<sub>x</sub>, whilst more recent studies have become more ambitious in their attempt to capture a range of externalities (not always in a manner which would give the methodological purist much by way of comfort). A problem here is that neither the unit damage costs, nor the dose response functions which typically underpin studies from which UDCs are derived, are known with certainty. There remains considerable uncertainty concerning the effects of a range of pollutants upon human health. It barely needs stating that the long-term consequences of some activities have barely been touched upon;
  - b) The significance of specific types of pollutant in the overall assessment of damages appears to be changing. GHGs may be becoming more important, even as the damages associated with SO<sub>x</sub>, NO<sub>x</sub>, PM<sub>10</sub>, etc. are being downplayed. PM<sub>2.5</sub> may become more important in analyses as awareness increases of the significance of the distinction between sub 10 micron particles;
  - c) Some attention is being given to the potential health effects— though we are not aware of any study which has attempted to make an assessment of the associated external costs – of bioaerosols from biological treatment plants;<sup>49</sup>
3. The focus of the majority of studies – or at least, of the valuation element - is on the emissions to the atmosphere associated with different processes. The effects of processes on, for example,

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47. A fairly extensive list of these is covered by the following studies: Broome, Vaze and Hogg (1999), COWI (2000), Eunomia (2006b, forthcoming) and Dijkgraaf and Vollebergh (2005).

48. Examples of this approach can be found in AEA Technology (1997), CIEMAT (ed.) (1998), Crapanzano *et al.* (1998), Linares *et al.* (1998), Rabl, Spadaro and McGavran (1998), TemaNord (2004) and HM Customs & Excise (2004).

49. See AEA (2001) and Casella Science and Environment (2001).

water pollution are generally not explored. This is of interest since few studies apply any discount factor to the emissions to atmosphere from processes which generate emissions over extended periods of time (such as landfilling, composting, anaerobic digestion, mechanical biological treatment, etc.). If a zero discount rate is being (implicitly) applied, it would be consistent to consider the emissions from landfills (and landfilled residues from incineration plants) over the longer term. Recent life-cycle studies suggest that if such emissions were, indeed, taken into account, they might become decisive in any analysis of environmental performance, especially if a zero discount rate is applied;<sup>50</sup>

4. Following from the above, only three studies appear to have applied a non-zero discount rate to account for the fact that the emissions from some processes occur over an extended period of time.<sup>51</sup> The use of a non-zero rate would tend to have the effect of reducing, in relative significance, the following externalities:
  - a) Atmospheric emissions from landfills, MBT facilities, compost facilities, anaerobic digestion facilities;
  - b) The benefits associated from the capture of methane from landfills for energy generation;
  - c) Emissions to water and land from the landfilling of residues, whether these be from incinerator bottom ash, incinerator air pollution control residues, untreated refuse, MBT-treated residues, etc. However, relatively few studies appear to have attributed any environmental cost to these;<sup>52</sup>
  - d) Emissions to air, land and water from the application of the products of biological treatment (i.e. composts or digestion residuals) to land, as well as those from any 'displaced products'.

The way in which the flux of greenhouse gases is handled in the non-zero discount rate case is very important for the final analysis, but extremely difficult. The choice of discount rate, as well as changing the sensitivity of the damages assessed to the time period over which those emissions occur, should also change the unit damage costs associated with the key climate change gases and their relative significance, since these gases have an effect which occurs over an extended period, and their residence-times in the atmosphere vary;

5. Closely related to the above is the issue of how to deal with emissions of carbon dioxide associated with biogenic carbon. Many cost-benefit analyses, like the majority of life-cycle studies, make the simplifying assumption that 'biogenic CO<sub>2</sub> can be ignored in the analysis'. Yet in comparative analyses, it only makes sense to ignore these emissions if including them would not affect the comparison. This is manifestly not the case in analyses which employ anything other than a zero discount rate since even if, over an infinite time horizon, the component of biogenic carbon which is not converted to methane is mineralised into carbon dioxide, the fact that it may occur over a varying time profile is significant for the analysis. Few enough studies take the dimension of time into account (see above). Of those that have done so, only one also seeks to account for changes in the time-profile of emissions of biogenic carbon dioxide.<sup>53</sup> If one is comparing methods for dealing with residual waste, excluding CO<sub>2</sub> emissions associated with biogenic carbon tends to bias comparative analyses in favour of thermal approaches (which send

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50. See, for example, Björklund (1998), Hellweg (2000), GUA, AWS and IFIP (2000) and Doberl *et al.* (2002).

51. See Eunomia Research & Consulting *et al.* (2002), Bartelings *et al.* (2005) and GUA, AWS and IFIP (2000).

52. See Nolan-ITU (2004), Sundqvist *et al.* (2002) and Dijkgraaf and Vollebergh (2004).

53. See Eunomia Research & Consulting *et al.* (2002).

CO<sub>2</sub> into the atmosphere instantaneously) and against biological ones, including landfill (which emit CO<sub>2</sub> over an extended period);<sup>54</sup>

6. In bottom up studies, the value placed upon the different end-points associated with the effects of different pollutants will affect the analysis. Different studies resort, for example, to the use of values based upon the value of a statistical life (VSL), whereas others use the value of life years (VOLY) lost approach. Similarly, in top-down studies, the unit damage costs are likely to be high or lower (other things being equal) depending upon whether the study from which the unit damage costs are taken made use of VSL or VOLY;<sup>55</sup> and
7. Where a study considers the implications of energy recovery, and makes an assumption that the energy generated 'displaces' another source of energy, the net effects of the energy generation depend critically upon which source of energy the study assumes to be displaced. The 'dirtier' the displaced source, the more advantageous (in the analysis) the generation of energy appears.

195. These issues are some of the critical ones in existing studies on the external costs of waste management. They explain much of the variation between studies. In any given study, the decisions in respect of the above methodological points are no less important than the quality of underlying data used. For this reason, it has to be said that the use of this type of analysis has to be handled sensitively. What is, and what is not included, and the methodological decisions made can, quite easily, skew analyses to favour one or other position.

#### **A.3.3.2 Landfill**

196. Where landfilling is concerned, the majority of studies concentrate on air emissions. Of these, methane has, unsurprisingly, received most attention. Relatively few studies have sought to look at an expanded range of emissions, or at emissions to other media. In the external costs literature, it is usually assumed that leachate is well managed so that there are no relevant emissions to land and water. This is a contentious (though simplifying) assumption, and it is almost certainly incorrect in the longer-term.

197. As regards methane emissions, the quantity of methane released to the atmosphere depends upon:

- The quantity generated in the landfill;
- The quantity collected by gas collection systems;
- The quantity of the uncollected methane which is oxidised as it passes through the cap; and
- The efficiency of combustion processes in converting methane to carbon dioxide and carbon monoxide.

198. Every one of these variables (with the possible exception of the last) is contested not least because each of the parameters is likely to vary over time (and space).

199. Landfills also emit other gases. The range of pollutants is considerable. In the UK, studies have suggested a link between landfills and the incidence of birth defects in their vicinity. However, the strength of this association is not considered by public authorities to be sufficiently strong to support any causal link.

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54. See Eunomia (2006a).

55. Recent estimates for the unit damage costs of different pollutants, in Europe, have been provided under the Clean Air for Europe Programme (see AEAT Environment (2005)). These show that decisions as to whether to use VSL or VOLY cause the unit damages to change by a factor of three or so for the majority of pollutants.

200. Landfills also lead to disamenity associated with dust, noise, odour, litter, etc. There have been a number of studies addressing the issue and one which sought to establish a meta-analysis of existing studies.<sup>56</sup> The transferability of these results is not clear.

201. As discussed above, the issue of discounting should be important in the context of emissions from landfills. However, this issue has not been given the attention it deserves from an economic perspective.

202. Also discussed previously, to the extent that landfills generate energy, the issue of 'which source is being displaced' assumes considerable relevance.

#### **A.3.3.3 Incineration**

203. As with other treatments, the focus of external costs of incineration has been on air emissions. Different studies seek to capture differing ranges of pollutants. Evidently, this will affect the analysis. Other key variables of infants include the following:

- the emissions assumed to result from the incineration process itself. For some emissions, these ought to be related back to the nature of the waste entering the facility;
- the nature of the energy recovery process, and hence the degree to which offsetting emissions can be attributed to the process;
- the degree to which it is assumed that materials are recycled at the facility (for example, steel extracted from bottom ash or bottom ash recycled for use as construction material);
- the way in which landfill residues are treated, particularly the air pollution control residues which contain hazardous components;
- whether the materials used in the construction of the plant are included in the analysis; and
- whether the inputs to the process -- including gas cleaning chemicals -- are included in the analysis.

204. These variables in turn depend upon a number of assumptions and performance issues related to the plant.

#### **A.3.3.4 Recycling**

205. It is standard practice in assessing the environmental costs and benefits of recycling to assess the external costs of manufacturing items using secondary materials and to subtract from these the impact is associated with making the same items using primary materials. The complexity of this analysis can readily be appreciated by the fact that it is not always the case that materials are recycled back into the product which gave rise to the recycled material.

206. As with other processes, the external costs associated with recycling depend upon a number of factors:

- the way in which any additional external costs associated with collection are assessed;
- where sortation is required, assumptions regarding emissions and health impacts from sortation processes;
- the range of pollutants covered by the analysis;
- the vintage of the primary and secondary processes being assessed;
- the way in which external costs of primary materials extraction and capture are accounted for; and

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56. See Brisson and Pearce (1995) and Cambridge Econometrics *et al.* (2003).

- the assessment of transport costs associated with the movement both primary and secondary materials.

207. For specific materials, such as paper and card, questions arise as to what would happen to the land if there was less recycling. This can lead in turn to some interesting questions as to the full extent of the benefits associated with recycling. For example, the US EPA in its recent work on greenhouse gas emissions associated with waste management, has undertaken forest sector modelling which suggests that greenhouse gas savings of far greater than most other studies have suggested, partly due to the way in which the forest sector is assumed to respond to changing rates of recycling.<sup>57</sup>

#### **A.3.3.5 Composting**

208. Few studies have attempted to capture, in anything like a comprehensive way, the external costs and benefits of composting. Negative externalities associated with composting include the following:

- Collection of the material for processing;
- Energy use in the process;
- Emissions to air from the process, particularly of greenhouse gases, ammonia, dust and bio aerosols. Some of these may be controlled by a combination of gas scrubbing and the use of bio filters. Efficiency with which these pieces of abatement equipment remove the emissions from the raw gas determine the overall emissions to atmosphere. Evidently, the opportunities for Bateman turf the exhaust gases from a compost facility depend critically upon whether or not it is enclosed. Hence, the emissions of pollutants to the atmosphere from open-air windrow facilities are likely to be greater than those from in vessel facilities;
- Assumptions regarding emissions of leachate from the composting process. It is common to see assumptions that leachate is generated in excessive quantities, leading to emissions to water courses or to sewers. Yet for many facilities, a key issue is to prevent the mass of material from drying out, so moisture is usually collected and re circulated at modern facilities; and
- Assumptions concerning the effects of the application of the material to land.

209. It is the positive externalities associated with composting that are rather more difficult to quantify. Some life-cycle based cost-benefit studies identify 'avoided externalities' associated with fertiliser avoidance, but they go no further than this.<sup>58</sup> Two studies have made a more concerted attempt to do this, and they identify a range of positive externalities.<sup>59</sup> However, this area of work is very much 'work in progress'.

#### **A.3.3.6 Anaerobic digestion (AD)**

210. Some similar considerations apply as with composting. The analysis is somewhat more complex, however, since the AD process can generate soil improvers, either stabilised through an aerobic process or unstabilised following the AD treatment as well as energy. The form of the energy delivered can also take different forms. Generation of heat and/or electricity is possible, but so is the delivery of upgraded gas into gas supply systems, or for use in vehicles. These different routes imply a corresponding range of assumptions concerning avoided external costs associated with the process.

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57. See USEPA (2002).

58. See Danish EPA (2003) and Sundqvist *et al.* (2002).

59. See Hogg *et al.* (2002) and Nolan ITU (2004).

### A.3.4 Approach taken in this study

211. The figures we have used in the case studies are believed to be broadly applicable to the areas concerned. It has not been possible to quantify the externalities associated with the change in the way waste is transported. To the extent that this may have occurred in the case studies, it is likely to have happened through, for example, some shift of waste from doorstep collection to bring sites and container-parks. The actual effect is highly dependent upon the locations of these, and their density (and hence, the degree to which people make 'special journeys' to such sites). Furthermore, as discussed previously, these externalities are already likely to be internalised to a significant degree in fuel costs in many (though by no means all) OECD countries, and certainly, within the countries from which case studies are taken.

212. Finally, it has not been possible to attribute an external cost to illegal disposal. Illegal disposal is, in all the cases studied, difficult to quantify, still less to assign to specific routes. We are not aware of any research which has been carried out to capture the externalities associated with fly-tipping. It may be worth pointing out, however, that one of the negative aspects of fly-tipping (though not the only one) – its disamenity effect – is frequently temporary as municipalities (sometimes others) clear it up, especially from those areas where it is most visible. Following this, it typically follows a formal disposal route. This is an expensive way to deal with waste, so where municipalities are responsible for clear-up, they tend to be well aware of the financial consequences for them of additional fly-tipping.

213. The external costs for specific activities are outlined below in Table 10.

**Table 10. Assumed external costs and benefits for specific waste activities**

Activity	External Benefit (low, €/tonne)	External Benefit (high, €/tonne)
Landfilling	-€ 9.61	-€ 44.75
Incineration (electricity recovery only)	-€ 32.45	-€ 62.77
Recycling of Paper / Card	€ 45.86	€ 94.17
Recycling of Glass	€ 11.37	€ 44.75
Recycling of Plastic	€ 46.49	€ 82.79
Recycling of Steel	€ 54.06	€ 98.32
Recycling of Aluminium	€ 620.28	€ 1,665.84
Recycling of Inert Wastes	€ 2.90	€ 2.90
Composting (with biofilter)	-€ 13.83	-€ 51.49
Home Composting	-€ 26.00	-€ 57.00
Waste Reduction	€ 290.00	€ 290.00

214. The low and high values reflect the use of 'low' and 'high' unit damage costs associated with the pollutants whose external costs are being assessed. The unit damage costs used are shown in Table 11.

**Table 11. Low and high damage costs used, and sources**  
€ per tonne

	Low	High	Source
CO <sub>2</sub>	€ 17	€ 62	Clarkson & Deyes
CH <sub>4</sub>	€ 283	€ 1,024	Clarkson & Deyes
N <sub>2</sub> O	€ 5,096	€ 18,473	Clarkson & Deyes
NH <sub>3</sub>	€ 17,000	€ 50,000	CAFÉ
VOCs	€ 1,100	€ 3,200	CAFÉ
PM <sub>2,5</sub> landfill	€ 1,530	€ 2,873	CAFÉ
PM <sub>2,5</sub> EfW	€ 58,564	€ 110,000	
SO <sub>x</sub>	€ 6,600	€ 19,000	CAFÉ
NO <sub>x</sub>	€ 3,900	€ 10,000	CAFÉ
CO	€ 2	€ 11	COWI
Cd	€ 24,611	€ 116,903	COWI
Cr	€ 163,664	€ 1,178,871	COWI
Cu	€ 61	€ 60	Enviros and EFTEC
Hg	€ 15,941,219	€ 31,882,437	COWI
Ni	€ 3,692	€ 24,611	COWI
Pb	€ 885,942	€ 1,771,884	CSERGE and EFTEC
Dioxin	€ 2,339,717,000	€ 17,630,080,000	COWI
As	€ 162,000	€ 1,168,000	COWI

Source: COWI (2000), AEAT Environment (2005), Clarkson and Deyes (2002), Enviros and EFTEC (2004) and CSERGE and EFTEC (1998).

215. It should be re-iterated that the valuation of external costs and benefits of each of the activities discussed is subject to various assumptions concerning the performance of the facilities under examination. In the case studies examined here, where incineration is the preferred management route for residual waste (in Gent), the facility generates electricity only. It is assumed that this displaces an 'average mix' of electricity generation.

216. Equally, the externalities associated with landfilling are highly dependent upon assumptions concerning the gas capture. Though reported rates of gas capture in the literature are often as high as 70%, this almost certainly relates to instantaneous captures rather than captures over the lifetime of the landfill. Lifetime captures may be far lower at many landfill sites. The high and low external cost figures presented here are for landfills with gas capture, the former with lifetime gas collection efficiency of 30%, the latter with lifetime collection efficiency of 70%.

217. For recycling, work undertaken by ECOTEC and CSERGE in the UK for what was then called DETR (now Defra) has been updated through the application of the damage costs discussed above.<sup>60</sup>

218. For composting, modelling is based upon a review of compost-related emissions and upon estimation of the benefits of compost application to soil. This builds upon work carried out for the European Commission.<sup>61</sup>

219. More details of the modelling approach can be found in a forthcoming report for WRAP by Eunomia.<sup>62</sup>

60. ECOTEC and CSERGE (1999).

61. Hogg *et al.* (2002).

62. Eunomia (2006b).

### A.3.5 Significance of the marginal cost of disposal for recycling / composting systems

220. For most organisations with responsibility for the collection of waste materials, a critical variable which drives the financial calculus as to whether or not to collect waste separately, and whether or not to seek to extract recyclables from is the marginal cost of dealing with residual waste. Because the variable which matters is the *marginal* cost, the way in which the relevant organisation accounts for the capital costs associated with residual waste treatment assumes considerable significance.

221. One can identify a number of different possibilities (which do arise in the real world):

1. In some situations, local authorities themselves have made (either individually, jointly with other authorities, or jointly with other private sector companies) investments with significant life-times in facilities whose throughput is relatively fixed. The obvious example of such a treatment is an incinerator. The way in which the sunk capital costs are accounted for, and the financial implications for the local authority of reducing (at the margin) the quantity of residual waste sent for treatment, have a bearing on the 'avoided disposal cost' which is perceived by the authority. This will probably be affected by the structure of ownership of the facility and the potential for revenue generation associated with any spare capacity made available by additional efforts to reduce waste generation and increase recycling;
2. In other situations, capital grants from central government or other sources lead to a situation in which any gate fee (effectively a cost per marginal tonne) is reduced by an amount equal to the equivalent annualised cost of capital divided by the functioning capacity of the facility;
3. In still others, local authorities may be dependent upon spot-prices for capacity at privately owned facilities. In these cases, the price may be determined in the market place, and will be influenced by the amount of capacity relative to the demand for it.

222. These considerations indicate that:

1. Under 1) above, the avoided cost of residual waste treatment, at the margin, could be zero (or even negative) if a contract demands a fixed throughput (a 'put or pay' contract), or if a municipal-owned facility is already running under capacity;
2. Under 2) above, even though the marginal cost may be positive, it may be reduced by grant funding; and
3. Under 3) above, the avoided marginal cost could be high or low depending upon the prevailing market situation.

223. The implication of these comments for the attitude of municipalities toward DVR charging systems is relatively clear. To the extent that DVR schemes reduce the amount of residual waste sent for treatment / disposal, they are likely to be most welcome in places where the marginal costs of treatment / disposal are high. Consequently, if contractual and / or funding arrangements act to depress this marginal cost, the cost implications of operating DVR schemes are likely to be correspondingly worse, at least in terms of the implications for the municipality's finances.

#### ANNEX 4: CASE STUDY 1 - TORELLES DE LLOBREGAT CATALONIA (SPAIN)

224. The description of the scheme presented in this chapter is based on two articles by Ignasi Puig Ventosa.<sup>63</sup> This has been supplemented by the author's analysis.

##### A.4.1 Background

225. Following the legal framework established by European Directives (notably, the waste framework Directive), the Catalan waste policy is based on a hierarchical approach.<sup>64</sup> This suggests that waste should be dealt through, in descending order of preference;

- Waste prevention
- Re-use and recycling in order to minimise the amount of waste requiring disposal;
- Generation of energy from residual waste; and
- Disposal to landfill.

226. In Catalonia, the Law 6/93, 15 July, regulating waste, was passed in 1993. This established the basis for the separate collection of biowaste since it stated that municipalities of more than 5,000 inhabitants must implement separate collection of biowaste before 1999. This effectively covered 178 municipalities, or 19% of Catalan municipalities, with a combined population of 5.7 million inhabitants (slightly less than 90% of Catalonia's total population).

227. Following this, the Municipal Waste Management Programme 1995-2000 set targets for recycling of each of five different fractions of waste. At the time, it was felt that the municipalities could seek to implement collection systems in whatever way they saw fit (whether using road containers, door-to-door collection, etc.).

228. Later on, under a new Municipal Waste Management Programme (PROGREMIC) covering the period (2001-2006), objectives were established for the separate collection of each of the different fractions of municipal waste. Regarding biowaste, the objective for separate collection is 40% - of total biowaste produced (including garden waste) - by the end of 2003, and 55% by the end of 2006. PROGEMIC also foresaw the potential implementation of a tax on landfilling.

229. These developments led to the replacement of Law 6/93 with two new laws. Law 15/2003, 13 June modified the Law 6/93, 15 July, regulating wastes. It established the basis for managing properly the commercial element of municipal waste in a manner independent of the municipal waste derived from households. It also incorporated the targets from PROGEMIC and stated that all municipalities must implement separate collection of biowaste. The particular focus on biowaste follows from the European Landfill Directive, which established targets for all European Union Member States for the reduction of biodegradable municipal waste being landfilled. Law 16/2003, 13 June, on waste treatment infrastructure financing and of the tax on landfilling of waste, established the grounds for the application, from 1 January 2004, of a tax of 10 €/per tonne of waste placed in landfills.

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63. See Puig Ventosa (2002) and (2003).

64. This section draws upon Coll Gelabert (2003).

230. As of early 2005, some 220 municipalities had implemented separate collection systems. Of these, 40 municipalities implemented collection of biowaste on a door-to-door basis. The others used various different road container systems.

231. The first Catalan municipality to put in place door-to-door collections of food waste was Tiana (in 2000). Several municipalities then followed, borrowing from Italian experience, in which food waste is targeted for separate collection on an intensive basis. This has proven to be a critical feature of cost-optimised collection systems in Mediterranean countries owing to the fact that removal of the most putrescible fraction from refuse (through frequent collections) makes it possible, even in hot climates, to reduce the frequency of refuse collection to levels which would otherwise be unacceptable to inhabitants (because of odours, nuisance, etc.). Indeed, such approaches are beginning to be adopted in countries with a more temperate climate too (such as Norway, and latterly, the United Kingdom).<sup>65</sup>

#### A.4.2 Description of scheme area

232. Torrelles de Llobregat is a small town with a population of around 4,300, situated in the metropolitan area of Barcelona (Spain). It covers an area of around 13.6km<sup>2</sup> and is still predominantly agricultural in its production structure.



#### A.4.3 Pre-scheme performance

233. Torrelles de Llobregat was the first town in Catalonia, along with Molins de Rei, to implement separate collection for biowaste. It did so in 1996, under the banner of the Residu Mínim project (wet and dry model). This model effectively relied upon separating waste into four streams: biowaste, paper, glass and inorganic matter (refuse and packaging are collected in the same bag).<sup>66</sup> The approach to collection

65. For a description of this type of system, see Amlinger, Ricci, Favoino and Hogg (2004).

66. Coll Gelabert (2003).

was based upon the use of large containers located in areas readily accessed by citizens (usually by the side of the road), a common approach in Mediterranean countries, but one which has been shown to capture food wastes, in particular, less effectively than door to door systems, and where the level of impurities in the collected biowaste tends to be higher than in door-to-door collection schemes.<sup>67</sup>

**Table 12. Pre-scheme approach to separate collection in Torrelles de Llobregat**

Collection	Kind of Waste	Collection Frequency
Door to door	Biowaste	3 times per week
	Paper and card	1 time per week
	Non - organic	2 times per week
Road containers	Glass (3 m <sup>3</sup> )	2 times per month
Green point	Furniture, toxic waste, emergencies...	

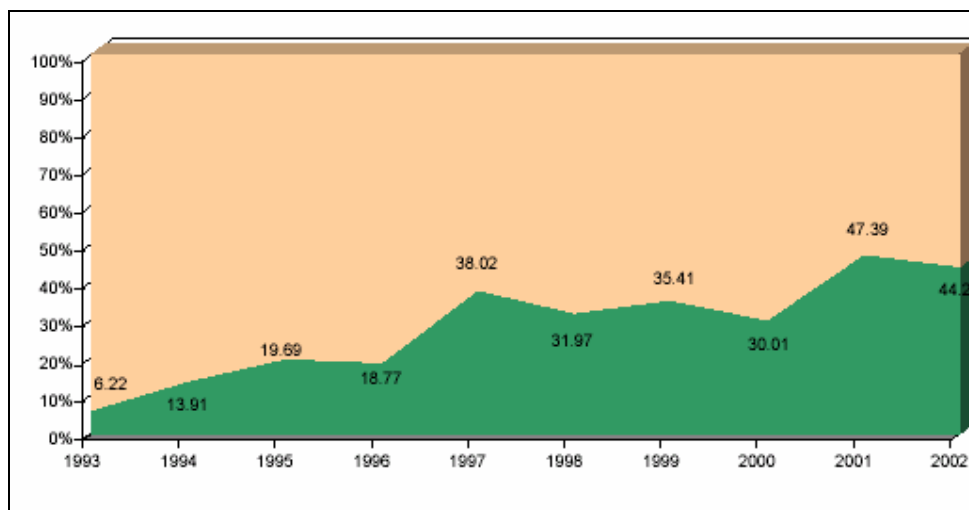
234. By 2002 Torrelles de Llobregat had already achieved a significant level of composting and recycling, accounting for some 45% of the total waste generated (which was amongst the highest rates of recycling achieved by Catalan municipalities). However, this level had stabilised, implying that a considerable percentage of the population was either not using the selective collection scheme at all, or that the accuracy of separation – the recognition rate – was not as high as it could be (see Figure 11).

235. The way in which citizens were paying for their waste collection was the conventional way in Catalonia at the time. All households paid the same amount, which in 2002 was €62.57 per year. It should be noted that this payment was made to cover the costs of collection of the waste containers, and did not include the costs of treating the collected waste. As far as the municipalities which lie within the Metropolitan Area of Barcelona are concerned, the costs of treatment are financed through the Metropolitan Environmental Charge for the Treatment of Municipal Waste (Tasa Ambiental Metropolitana de Gestión de Residuos Municipales, or TAMGREM).<sup>68</sup>

67. The issue of impurities is one which is of greater or lesser significance in different countries depending upon the nature of the standards which are applied for the spreading of treated biowastes on land (see Hogg *et al.* (2002b) for a discussion). In any case, from the perspective of operators of compost / anaerobic digestion plants, the presence of impurities tends to increase costs associated with the process.

68. The Tasa Ambiental Metropolitana de Gestión de Residuos Municipales is paid by the households straight to the Entitat Metropolitana de Serveis Hidràulics i Tractament de Residus (EMSHTR, or Metropolitan Organisation for Water Services and the Treatment of Wastes) (except in the case of some municipalities in the Barcelona Metropolitan region, neither of which is Torrelles). The EMSHTR is an association of most of the municipalities in the metropolitan area of Barcelona which provides the waste treatment service, but not collection. The TAMGREM used to be levied on the basis of the water consumption of each household (according to a rather complicated formula), and the tax was charged to households in the water bills. However, in 2004, the tax was modified to allow those households living in those municipalities achieving better environmental results to pay less to EMSHTR. Furthermore, the levy is no longer denominated TAMGREM (Tasa Ambiental Metropolitana de Gestión de Residuos Municipales) but TMTR (Taxes metropolitanas de tractament i deposició de residus municipals). These changes took place, however, after the Torrelles PAYT scheme ceased to exist (see later). (I am grateful to Ignasi Puig-Ventosa for these comments – the revised scheme, designed to incentivise municipalities' efforts to reduce residual waste, is described in Puig-Ventosa (2006)).

**Figure 11. Evolution of recycling in Torelles de Llobregat**  
Per cent



Source: Puig Ventosa (2003).

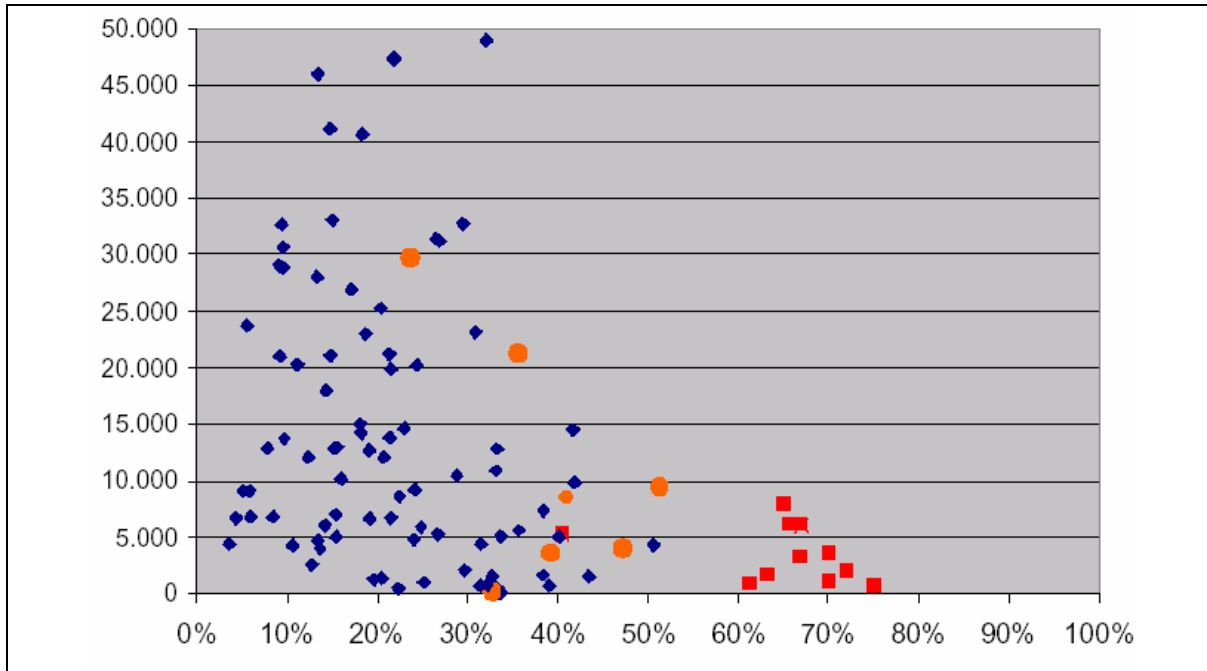
236. As regards commercial wastes, the commercial establishments were effectively divided into three categories, and the payment required was based upon the classification of the establishments into these categories.

#### **A.4.4 Rationale for scheme introduction**

237. The results of door to door collection systems in Catalonia had made clear what levels could be achieved through voluntary participation in quality separate collection schemes. Recognising that the existing system (based on the concept developed in the Residu Minim project) had reached its limits, and in particular, that the capture of biowaste was not as good as in door-to-door collections (see Figure 12), the Council decided that it should implement a door-to-door collection scheme, following other Catalan municipalities. In these systems, the different waste materials are collected on different days, with citizens and commercial enterprises leaving their waste at the entrance of their buildings for collection.

**Figure 12. Performance of different systems for biowaste recycling**

Systems using road containers and systems using doorstep collection for biowaste; y-axis = number of inhabitants, x-axis = combined recycling and composting rate in per cent



Source: Coll Gelabert (2003).

Key:

- Door to door collection system 1<sup>st</sup> generation (started in 2000-2001: Tiana, Tona, Riudecanyes, etc.)
- ◆ Street containers (5 materials: biowaste, paper, glass, envelopes, refuse = Valor separation model).
- Street containers (4 materials: biowaste, non-organic, paper and glass = Residu Mínim model (or Wet & Dry model)).

238. However, the main innovation that the Council of Torrelles de Llobregat decided to introduce was a new waste charging system. The power to implement such a system is made available under the Fiscal Ordinance Regulating the Tax for Collection of Municipal Wastes, and is based upon a pay-per-sack approach, though with additional elements based around subscription systems for specific containers.

239. Until 2002, as discussed above, in the majority of the Spanish municipalities, the waste charge was a flat annual fee, the same for every household. In the case of commercial enterprises, a fee was paid according to the type of activity. This form of charging was deemed unfair since people or activities generating small amounts of waste were actually subsidising producers of greater quantities of waste.

240. To overcome this problem and particularly to foster waste recycling and minimisation, Torrelles de Llobregat decided to implement a pay-as-you-throw scheme, linking the actual payment to the amount and type of wastes generated. This was the first example in Spain of such a scheme and was supported by both the regional Government (Junta de Residus, Generalitat de Catalonia) and the Metropolitan Area of Barcelona (Entitat Metropolitana del Medi Ambient). As far as we are aware, it is still the only such scheme for municipal waste which has been implemented in Spain (and as we shall see, it has now been terminated).

241. The new system was implemented on 14 January 2003. Citizens and commercial enterprises were asked to leave their waste every night in front of their building for collection. For households, the system consisted of the following:

- Biowaste was collected with no additional charge three times per week in compostable sacks within brown buckets of 25 litre capacity with the sacks and the buckets provided by the municipality. A fourth collection was operated in the summer months;
- Paper and card were collected once per week at no additional charge. They were to be presented in such a way as not to present problems of litter on the streets;
- Glass was the only material which was still to be collected through a bring scheme (using igloos), also free of charge.

242. All other wastes (mainly packages and residual wastes) were left for collection inside special standardised plastic sacks provided by the Council. The cost of these sacks formed part of the waste charge paid by households, and they were distributed through local retailers.

243. The sacks for residual waste were priced as follows:

- 40-litre bag €0.60 each
- 100-litre sacks €1.50 each (available for commercial enterprises).

244. The intention was to create an incentive for waste reduction and recycling.

245. Apart from these fractions, the following fractions were also collected:


- Nappies (or diapers) within special opaque white sacks;
- Garden waste, other than large branches, placed in specific sacks on the same day as the collection of kitchen wastes; and
- Garden waste in the form of larger branches could be taken to the civic amenity site, or directly to the compost plant.

246. The sacks for the nappies and the garden waste had the logo of the municipality on them as well as the name of the waste fraction for which they were to be used. The garden waste sacks were biodegradable, and were charged at €0.40 per 50 litre sack.

247. The municipality established a tool for citizens to use to calculate the costs of their own waste management decisions (see Figure 13). This allowed for discounts of 50% of the fixed rate for:

- Those households engaged in home composting. Such households were supposed to be composting in the previous year. Home composters were supposed to notify the Town Hall administration, and once a year the Town Hall was supposed to visit them to inspect their activity. However, given the early termination of the scheme (see below) whether these controls actually took place, and whether they would have been successful if they had, is difficult to know.
- Those households in the most remote locations. These were not served by a collection of such high quality. They were required to use the same sacks and take them to specific closed areas designated for their use.

Figure 13. Calculation tool for households in Torelles de Llobregat



**Càlcul estimatiu de la Taxa de Recollida de Residus Municipals a Torelles de Llobregat. Any 2003**

**Part Fixa** **35.00 €/Any**

**Part Variable:** [nº Bosses de brossa inorgànica x 0,6 €/bossa] + [nº Bosses compostables residus vegetals x 0,4 €/bossa]

**Beneficis fiscals:** Bonificació de la part fixa per realitzar compostatge casolà i/o viure en un habitatge disseminat.  
Les famílies nombroses tenen bosses compostables gratuïtes en proporció al nombre de membres

**Estimació del Nombre de Bosses de Brossa Inorgànica**

1. Nombre de persones que viuen a la llar  1  2  3  4  5  6  7  8  9  10  11  12

2. Pautes de Consum [Adquisició de productes amb pocs embalatges, envasos ambientalment més correctes, refús de bosses de plàstic]  Sempre que tinc l'ocasió  Força vegades  Alguna vegada  Mai

3. Us de la Deixalleria  Un cop per setmana  Un cop cada quinze dies  Un cop al mes  Un cop al trimestre  Un cop al semestre  Un cop a l'any

4. Gestió dels envasos i embalatges (Plàstic, Llaunes, Brics, etc.) mitjançant  la Deixalleria  la Bossa de Brossa Inorgànica [plegats i aixafats]  la Bossa de Brossa Inorgànica [sense plegar ni aixafar]

**Estimació del Nombre de Bosses de Brossa Inorgànica necessàries a l'any** **50 bosses**

**Nombre de Bosses Inorgànica per setmana** **1.0 bosses/set**

**Estimació del Cost Anual d'Adquisició de Bosses de Brossa Inorgànica** **30.00 €/Any**

**Estimació del Nombre de Bosses Compostables de Residus Vegetals**

1a. Teniu Jardí?  Sí  No

1b. Superfície del jardí  0 m2  0-99 m2  100-249 m2  250-499 m2  500-999 m2  1.000-1.999 m2  2.000-2.999 m2

2. Tipus de residus vegetals que genereu en el vostre jardí  Només gespa i fullaraca  Gespa, fullaraca, esporga d'arbustos  Gespa, fullaraca, esporga d'arbustos i arbres (xiprers, pins, etc.)

3. Com penseu gestionar els residus vegetals?  Mitjançant la Planta de Compostatge o la Deixalleria  Mitjançant l'autocompostatge  Mitjançant la recollida porta a porta

**Estimació del Nombre de Bosses Compostables per Residus Vegetals necessàries a l'any** **0 bosses**

**Nombre de Bosses Compostables per Residus Vegetals per setmana** **0.0 bosses/set**

**Estimació del Cost Anual d'Adquisició de Bosses Compostables per a Residus Vegetals** **0.00 €/Any**

**Observació:** La Recollida Porta a Porta dels Residus Vegetals només s'efectuarà dels residus vegetals lliurats dins de bosses compostables (gespa, fullaraca o esporga trocejada)

**Beneficis fiscals**

1a. Fas autocompostatge?  Sí  No

1b. Viu en un Habitatge disseminat?  Sí  No

<b>Part Fixa:</b>	35.00 €/Any	-	0.00 €/Any	=	35.00 €/Any	
<b>Part Variable:</b>	30.00 €/Any	+	0.00 €/Any	=	30.00 €/Any	
<b>TOTAL:</b>					=	<b>65.00 €/Any</b>
<b>Estimació del Cost Total de la Taxa</b>			Per unitat familiar	65.00 €/Any	equivalent a	10,815 Pts/Any
			Per persona	16.25 €/Any	equivalent a	2,704 Pts/Any

248. The new collection system was *ex ante* estimated to increase the city's operational costs related to waste management by 17 percent. To ease the transition to the new DVR system during the first year, the council designed the variable fee to pay for 40 percent of the total cost of collecting residents' waste. A flat fee of (€35), similar to the tax in the previous collection system but at half the value, was maintained to pay for another 40 percent of collection costs. The remaining 20 percent of the costs of waste collection were absorbed within the municipal budget, as it had been in previous years.

249. The anticipated increase in costs could not simply be attributed to the introduction of the charging system. One of the major causes of cost increases is likely to have been the change in the collection scheme from one based upon collection in road containers to a door-to-door system. It is possible – even

likely - that the charging system may have reduced the overall costs of implementation of the new collection system relative to a counterfactual scenario in which there is no charging in place.<sup>69</sup>

250. For commercial enterprises, the fixed element of the overall charge was based upon four categories, three of these being much as prior to the DVR scheme's introduction, the fourth being a new category.

**Table 13. Fixed part of charge for commercial enterprises in Torrelles de Llobregat**

Type of Enterprise	Fixed Fee
Restaurants, supermarkets, petrol stations, hostels, bed and breakfast, hostels, warehouses (except those included in the category below) and other similar entities.	150 €
Food shops, fish shops, butchers, hardware stores, locksmiths, carpenters, tobacconists, kiosks, bars, financial enterprises, etc.	85 €
Garages, shoe shops, gift shops, pharmacies, haberdashery stores, clothes shops, bakers, distribution offices, professional activities, general commerce.	60 €
Industrial, and other similar, premises.	300 €

251. The variable element of the charge for commercial waste producers is composed of two elements. The first element is based upon a payment for each green translucent sack for residual waste. The charges are the same as for domestic waste.

252. The second part of the variable charge relates to organic waste. The commercial entity pays a charge whose magnitude depends upon the number of containers used, their size, and the frequency of their collection. Three different container volumes are available, and the collection frequency is either twice or four times per week. The containers have different colour stickers depending upon the collection frequency chosen. Those which are collected only twice a week are collected at either end of the week. It is possible for enterprises to choose containers with different frequencies of collection.

253. It should be noted that where commercial enterprises generate waste which is similar in quantity and nature to household waste, they are allowed to make use of the same sacks as are used by the households.

**Table 14. Charges for commercial waste collection in Torrelles de Llobregat**

Container Size	Collections per Week	Charge (per year) (€)
90 litres	4	75.00
240 litres	4	150.00
660 litres	4	225.00
90 litres	2	37.50
240 litres	2	75.00
660 litres	2	112.50

#### A.4.5 Approach to illegal dumping

254. In Torrelles de Llobregat, a number of forms of potential evasion were identified prior to the scheme's implementation. These were included in the relevant chapter of the municipal waste collection ordinance which described the regime for the application of sanctions.

69. In the general case, the degree to which this is likely depends upon a) the extent to which the charging scheme itself implies additional costs b) the extent of waste reduction c) the cost of refuse collection and disposal, and d) the costs of separately collecting refuse for recycling or composting. In this case, as will become clear, there appears to have been some reduction in the quantity of waste collected. Consequently, there may be savings offsetting the additional costs.

255. In Torrelles, Puig Ventosa reports that two weeks after the system's introduction, there was evidence of some waste being taken to containers located in other municipalities, but problems of illegal dumping within the municipality itself were not detected. There were some isolated cases of incorrect use of the corresponding bags. Most notable was the significant increase in the use of the container-park .

256. The most direct sanction available to the authority was its refusal to collect materials which were wrongly presented. During the first few weeks, a blue sticker was put on the door of those houses that presented one or other fraction incorrectly, but the material was collected anyway. The sticker was intended to be informative telling residents of the change of system.

257. From the third week onwards, where the household's behaviour was still not in line with what the new system required, a red sticker was used, and the materials were not collected. The red sticker explained why the materials had not been collected, and repeated use of red stickers would trigger sanctions. Where there were wastes which had been dumped, the municipality made clear its intention to examine the waste to seek to identify the offender.<sup>70</sup>

#### A.4.6 Results of the scheme

258. In the period during which the scheme operated, there appears to have been enough evidence to suggest that the charging system and the accompanying service changes incentivised correct participation and gave rise to a reduction in waste, although the extent of this is more difficult to evaluate than the change in recycling.

259. Table 15 shows the comparative performance of the system from January to July for the years 2002 and 2003. The most significant observations are the reduction in the quantity of collected wastes of 38%, and the increase in the selective collection from 33% to 89% if one includes the bulky and CA waste fractions, or from 17% to 51% if one includes only organic materials, paper and glass. Figure 13 illustrates the change in the collected fractions graphically.

260. Puig Ventosa is keen to stress not just the increased quantity, but also the quality of the segregated materials. Collected organic materials more than doubled, especially prunings (collected from the container-park ) which tripled in quantity. Packaging materials are also collected at the container-park.

261. As far as residual waste is concerned, Puig Ventosa suggests that three main causes are behind the reduction in the quantity of waste:

1. Movement of trade waste into other streams. Residual waste from traders (small factories, industries, construction, etc.) might previously have been collected by the municipality, but since the collection would no longer be 'free', this waste would not find its way into the municipal collection. It should be noted that this no environmental benefit could be attributed to this shift since it is probably still collected, and its destination may be exactly the same as before;
2. Genuine waste reduction owing to a change in the habits to the population; and
3. 'Waste tourism' of residual waste (the transfer of waste to other municipalities).

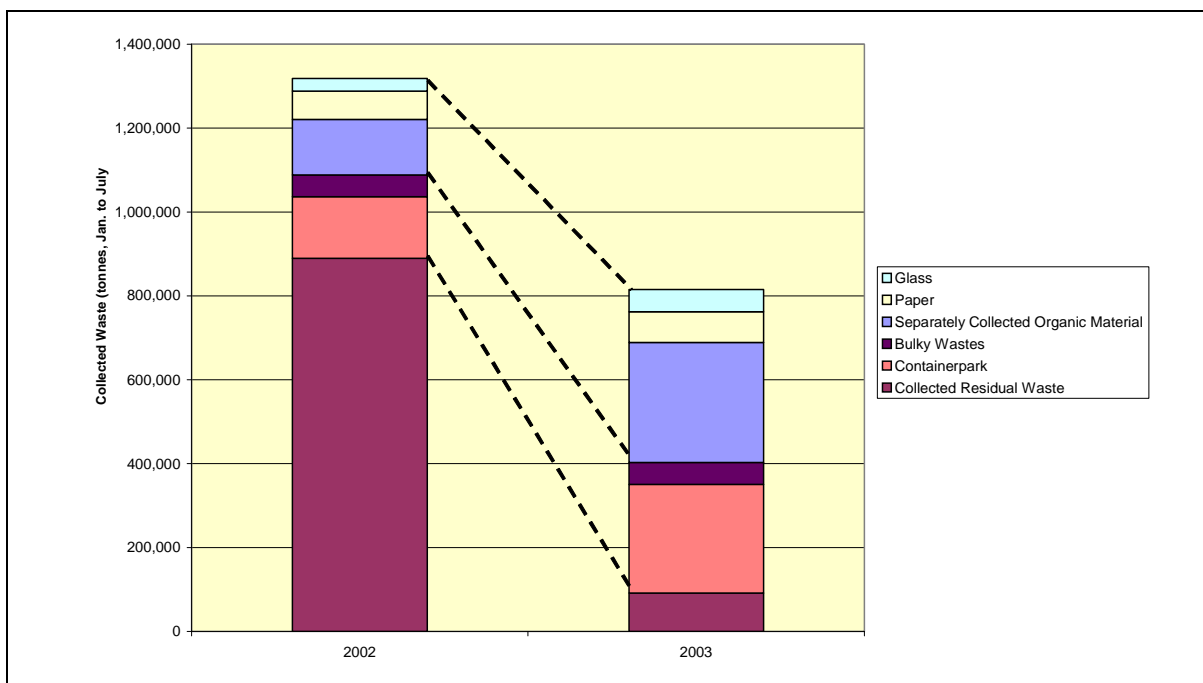
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70. As an approach to dealing with potential abuse of charging systems, it is usually recommended that enforcement in the period immediately after the system's introduction is quite stringent. Fullerton and Raub (2004) make the point that: *'Nobody has estimated both short run and long run effects [of charging schemes upon dumping], but we suspect that some individuals might "protest" the imposition of a price on garbage by dumping initially – but then return to compliant behavior'* The USEPA (1998) has made a similar point in the past.

**Table 15. Comparative performance of the different fractions in Torrelles de Llobregat**  
January to July, 2002 and 2003

<b>Waste Fraction</b>	<b>2002 (kg)</b>	<b>2003 (kg)</b>	<b>Change (%)</b>
Separately Collected Organic Material	132,518	286,189	115.96
<i>Organic material (door-to-door)</i>	108,750	209,590	92.73
<i>Prunings (door-to-door)</i>	13,638	38,270	180.61
<i>Prunings (container-park )</i>	10,130	38,329	278.37
Collected Refuse (door-to-door)	889,200	92,300	-89.62
Paper	67,360	72,450	7.56
<i>Paper(door-to-door)</i>	67,360	50,040	-25.71
<i>Paper (container-park )</i>	0	22,410	
Glass	29,951	53,080	77.22
<i>Glass (door-to-door)</i>	24,880	40,710	63.63
<i>Glass (container-park )</i>	5,071	12,370	143.94
Bulky Wastes	52,030	52,745	1.37
<i>Recycled Bulky Wastes</i>	38980	40,125	2.94
Total Container-park	146,995	258,133	75.61
<i>Packaging</i>	9,226	59,407	543.91
<i>Inert and recoverable Materials</i>	125,526	188,721	50.34
<i>Special Wastes</i>	12,303	10,005	-18.68
<b>TOTAL</b>	<b>1,318,054</b>	<b>814,897</b>	<b>-38.17</b>
Separately Collected Organic Material as % Total	10%	35%	
Separately Collected Paper and Card as % Total	7%	15%	
Collected Bulky Wastes as % Total	4%	6%	
Collected CA Site Wastes as % Total	11%	32%	
Total Separately Collected as % Total	33%	89%	
<b>OTHER ITEMS</b>			
No. of Inhabitants	3,901	4,108	
No. of Container-park Users	3,700	9,420	154.59

**Figure 14. Changes in Collected quantities and quantities recycled in Torrelles de Llobregat**  
January to July, 2002 and 2003.



262. Through efforts made to educate commerce and industry, and with the threat of sanctions, many industries that were previously using the municipal system illegally have ceased to do so. This accounts for some of the reduction in the quantity of collected waste since January 2003. As such, it should not properly be considered as 'waste reduction'. The waste has simply crossed administrative boundaries, though such a move is important if commercial operations are to be faced with the financial costs of managing their waste.

263. The council estimated that approximately 10 percent of the waste stream was being disposed of outside the program's boundaries. Again, this cannot be considered 'waste reduction'. Indeed, this activity imposes a cost on other municipalities who have to deal with the material through their own collection infrastructure.

264. The number of users of the recycling centre almost tripled, primarily due to the fact that some materials which cannot be collected separately at the doorstep can be disposed of free of charge, if properly sorted, at the recycling centre. The alternative would be to have them collected as residual waste using standardised bags and consequently incurring costs to the user. The recycling centre was receiving 0.67 visits per household per month, which is the highest rate in Spain, according to the council.

265. Prior to implementing the user fee-based system, the council and regional administrations spent approximately €18,000 in consulting fees to design the collection and fiscal system. Approximately €30,600 was spent on communication and information dissemination. The collection cost for the first year has been €90,242.

#### **A.4.7 Fate of the scheme**

266. Despite the local participation and a high level of cooperation in designing the PAYT system, the council reported that there was a lack of consensus between local political parties, which caused some citizens to be reluctant to use the standardized bags.

267. During local elections in 2003, one of the political parties campaigned on the basis that they would remove the system of separate collection altogether (not merely the system of charging). When the political party in question gained power, the charging system was abandoned, but the system of separate collection remains in place.

268. This experience – the first of its kind in Spain – came to a halt in the same year it began.

#### **A.4.8 Costs and benefits of the scheme**

269. For this example, it is not adequate to use a ‘before and after’ comparison of the achievements of the scheme. This is because the scheme was introduced at the same time as considerable changes were made to the collection system itself. For this reason, we have estimated the costs which are attributable to the service itself, and the costs due to the charging scheme.

270. In the absence of charging, we estimate that:

- A similar, but slightly lower, recycling rate would have been achieved;
- The same quantity of waste would have been collected as before;
- The routes through which the material would have been collected would not have changed;
- The collected commercial waste would have remained in the municipal waste system;
- There would have been no ‘waste tourism’.

271. The exact nature of these is difficult to estimate.

##### **A.4.8.1 Private costs**

272. The municipality covers the cost of collection only. This is an important point to make since the private costs of the total system include the costs of treating the material collected. To the extent that the system includes waste reduction, then any cost savings will relate partly to the savings on treatment.

273. Prior to the scheme’s introduction the costs were of the order €70 per household. The scheme increased these to €88 per household. As regards treatment, there was a reduction in residual waste treatment / disposal equivalent to approximately 485kg per household. If the disposal of residual waste is via landfill, costs in Catalonia may be of the order €40 per tonne.<sup>71</sup> If disposal was via one of the EcoParcs in Catalonia, the resource cost might be in excess of €80 per tonne. We have used the figure of €80 per tonne in this analysis.

274. There would be an increase in the requirement for composting due to an increase in source separation of biowaste of around 94kg per household. Assuming the composting was taking place at an in-vessel composter, the cost might be of the order €55 per tonne.<sup>72</sup>

275. Some of the costs of the system are externalised to others through waste tourism. It has been estimated that 10% of waste moved across boundaries through this effect. Arguably, this merely shifts the costs onto others. We estimate that this cost is approximately equal to 10% of the per household cost prior to the scheme’s introduction.

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71. See Hogg *et al.* (2002c) (Annexes to the report).

72. See Hogg *et al.* (2002c). This points toward a convergent figure for the costs of in-vessel composting of the order €55 per tonne (evidently this is scale- and technology-dependent).

276. A notable effect of the scheme has been the increased number of visits to the container-park for the delivery of recyclable materials. It is not clear to what extent this incurs additional costs, in terms of time and travel, to the householders. What is clear is that the increase in visits has been highly significant. This most likely reflects the fact that many of the materials which arise in large volumes in the waste stream – low bulk density materials such as plastic containers and cans – could not be recycled through door-to-door collections. Whilst this will have kept collection costs lower for the authority, these costs will have been incurred by householders instead.

277. The per-household costs are summarised in Table 16. It is clear from this that the disposal route is important in understanding the net system costs.

**Table 16. Change in per household costs following scheme introduction**

	€per household, disposal to landfill	€per household, disposal to EcoParc
Collection Before Scheme Introduction	€70.00	€70.00
Collection After Scheme Introduction	€88.00	€88.00
Reduced Disposal Costs per Household	-€19.39	-€38.80
Increased Composting Cost per Household	€5.14	€5.14
Externalised Through Waste Tourism	€7.00	€7.00
Net Change in Cost per Household	€11.58	-€9.00

278. In general since the savings on disposal costs drive the benefits associated with waste reduction and recycling, the incentive provided by charging schemes generates greatest financial benefits in situations where the marginal costs of residual waste disposal are high. In some circumstances, residual waste costs can be high, but the marginal cost may in the short- to medium term be zero owing to the nature of contracts agreed between a municipality and a contractor.<sup>73</sup>

279. It should be re-emphasised that the above cost calculations are an assessment of the costs not only of introducing the new charging scheme, but also, the costs of the new door-to-door collection system.

#### **A.4.8.2 External costs and benefits**

280. Table 18 below shows the net external costs and benefits of the scheme changes that have been quantified. To estimate the benefits associated with the reduction in the quantity of material going to landfill, the reduction in residual waste has been adjusted to reflect the amount of material which is believed to have been collected through other routes. This is shown in Table 17. To arrive at these figures, it has been necessary to make some estimates. These are:

- That waste tourism accounted for 15% of the waste which was collected before the scheme;
- That movement of commercial waste away from the municipal stream accounted for a further 10% of waste which was collected before the scheme;
- That genuine reduction in waste accounted for a further 5% of waste which was collected before the scheme;
- That home composting accounted for a further 5% of waste which was collected before the scheme; and
- That illegal disposal accounted for the balance of the reduction in collected material (around 3% of waste which was collected before the scheme)

73. A personal communication with a friend from Germany with experience of charging schemes indicated that one scheme was not considered beneficial to the municipality since it was incurring costs in diverting material away from an incinerator which was running at less than capacity. Since the marginal costs of using the incinerator were low for the municipality, the system of charging was considered quite costly.

281. These are estimates only, but are believed to be plausible. However, it must be stated that there remains a paucity of information – across most studies of DVR schemes - seeking to ‘track’ waste in pre- and post-scheme scenarios (no least because such an exercise is far from straightforward).

**Table 17. Factors accounting for reduction in total waste collected**

	Quantity (tonnes)
Total Quantity of Waste Collected Before Introduction of Charging Scheme	1,318,054
Total Quantity of Waste Collected After Introduction of Charging Scheme	814,897
Difference (before – after)	503,157
<i>Estimated Quantity Accounted for by Waste Tourism (A)</i>	197,708
<i>Estimated Quantity Accounted for by Re-routing Commercial Waste (B)</i>	131,805
<i>Estimated Reduction due to Home Composting (C)</i>	65,903
<i>Illegal Disposal (D)</i>	41,838
<i>Genuine Waste Reduction (E)</i>	65,903
Reduction in Collected Residual Waste Collected After Scheme Introduced (F)	796,900
<b>Estimated Reduction in Quantity of Waste Disposed = F – (A+B+D)</b>	<b>425,548</b>

**Table 18. Net external costs and benefits of the change in Torrelles de Llobregat**

	Mass Effect (kg)	Low	High
Residual Waste	-425,548	€4,091	€19,042
Paper and Card	5,090	€233	€479
Glass	23,129	€263	€1,035
Steel	21,327	€1,153	€2,097
Aluminium	3,764	€2,334	€6,270
Plastics	25,091	€1,166	€2,077
Inert wastes	63,195	€183	€183
Special wastes	-2,298	n.i.	n.i.
Compostables	153,671	-€2,126	-€7,912
Genuine Waste Reduction	65,903	€13,181	€13,181
Home Composting	39,542	-€1,713	-€3,756
<b>Net External Benefit</b>		<b>€18,766</b>	<b>€32,696</b>
<b>Net External Benefit Per Household</b>		<b>€11</b>	<b>€20</b>

n.i. = no information

282. As discussed above, the scheme clearly led to an increase in journeys to the container-park. The usage per household appears to have increased from around 0.26 per month to 0.67 per month, an increase of 0.41 per month, or 4.9 per year. Supposing each journey to and from the site takes 40 minutes, then the time spent in these journeys would be of the order 3.25 hours. It is not always the case that such journeys are made exclusively for the purpose of using the container-park. We have assumed that 30% of the time is attributable directly to the activity, or 0.98 hours per household. The additional cost attributable to this time clearly depends upon the value of time associated with it. A wage rate of €20,000-25,000 equates to an hourly rate, before taxes and other deductions, of €11.59-14.49 per hour. In what might be considered an extreme case, therefore, the value of the time foregone might be of the order €8-10 per household per year (making some allowance for taxes and deductions).

283. Including this as an external cost, without any counterpart benefit, would therefore reduce the benefits of the system change to around €1-12 per household.

284. It should be noted that this does not include the external costs of illegal disposal. We estimate this may be of the order 41,800kg per annum. In order for the above net external benefits to become negative, the external costs of illegal disposal would need to be in excess of €49 per tonne in the ‘low damages costs’ case, and €81 per tonne in the ‘high damage costs’ case, or, where time is taken into account, €39 per tonne and €71 per tonne respectively. Since it has been assumed that the illegally tipped waste is still

landfilled (or has negative effects of a similar magnitude), these impacts would need to be associated with other impacts of fly-tipping, such as disamenity and ecological impacts. It seems unlikely that they would be quite so high as this.

#### A.4.8.3 Summary costs and benefits

285. The case suggests the following:

- Net private costs per household of €11.58 per household if the avoided disposal is landfill or -€9.00 per household if the avoided disposal is a non-landfill treatment; and
- Net external benefits of between €1-€20 depending upon whether high or low unit damage costs are used. This excludes external costs associated with illegal disposal. These fall (based on a range of assumptions) by around €8-10 per household once one accounts for time spent by households in making greater use of the container-park.

286. The possible permutations for the balance of costs and benefits are shown in Table 19. This shows that the balance of costs and benefits is negative only in the case where damage costs are low, and the avoided disposal route is lower cost landfill. Even in the cases where the costs of time are considered, the balance of costs and benefits is negative (there are net benefits) in all other cases. In the most positive cases, the benefits exceed €20 per household.

287. These costs and benefits are not attributable solely to the charging scheme. They are attributable to a combination of a change in service and the introduction of the charging scheme. We have not tried to separate these out in this particular case, but perhaps the important thing is the fact that the combined scheme potentially delivers significant net social benefits, notably where the avoided form of disposal is not landfill.

**Table 19. Balance of costs and benefits of DVR scheme, Torrelles de Llobregat**

	Disposal to Landfill		Disposal to Anaerobic Digestion	
	Low Damage Costs	High Damage Costs	Low Damage Costs	High Damage Costs
Net Change in Private Cost per Household	€ 11.58	€ 11.58	-€ 9.00	-€ 9.00
Net External Benefit Per Household, Time Excluded	-€ 11.42	-€ 19.90	-€ 11.42	-€ 19.90
Net External Benefit Per Household, Time Included	-€ 1.00	-€ 12.00	-€ 1.00	-€ 12.00
Balance of Costs and Benefits Per Household, Time Excluded	€ 0.16	-€ 8.32	-€ 20.42	-€ 28.90
Balance of Costs and Benefits Per Household, Time Included	€ 10.58	-€ 0.42	-€ 10.00	-€ 21.00

288. These costs and benefits do not account for:

- The potential disbenefits associated with illegal disposal (other than those concerned with its disposal); and
- Changes in associated transport externalities. These could be assumed to be broadly internalised in the private costs of transport.

289. On balance, whilst negative social costs are possible under the scheme, the scheme appears more likely to offer net benefits. Evidently, the magnitude of these depends upon a range of assumptions. The assumptions made concerning the value of time spent in engaging in additional recycling activity are potentially important, and where the private costs of residual waste treatment are low, these could even be decisive in an analysis of costs and benefits. It is perhaps worth stating once again that there are more

general limitations in terms of the scope of coverage of costs and benefits of different waste treatments, with long term effects of some of the cheaper options such as landfill being rather difficult to quantify.

290. Important issues which the scheme appears to have raised relate to movement of waste into other routes. This may be a particular problem in small jurisdictions where a charging system is applied with no other schemes operated nearby. Effectively, the perimeter of such an area relative to the total area is large. All households are likely to be close to the perimeter, and they may find it easy to move waste across administrative boundaries.

291. The increase in visitors to the container-park is also of interest. This can probably be explained best by reference to the fact that the scheme effectively charged on the basis of volume, and some of the low-density / high-volume materials such as plastic bottles and cans could not be recycled through the door-to-door collection service. Different schemes – notably, those with greater materials coverage – are likely to give rise to smaller numbers of additional movements. It is worth stating also that, to the extent that movement of materials onto the container-park is made more likely through charging schemes, any additional costs attributable to these movements are likely to be significantly lower where the density of sites is high (so that journey distances / times are kept down), and where the sites are located in places which are close to areas which are frequently visited by citizens (so that the number of ‘dedicated’ journeys is minimised).

## ANNEX 5: CASE STUDY 2 – LANDKREIS SCHWEINFURT, SCHWEINFURT (GERMANY)

292. This case study is based on an earlier report, undertaken with the assistance of representatives of the municipality and the company implementing the DVR charging system.<sup>74</sup> We have tried to concentrate on the salient issues affecting the costs and benefits of the system as implemented but it has been necessary to provide some of the detail of the earlier work to set the analysis in context.

### A.5.1 Pre-scheme Situation

293. The county of Landkreis Schweinfurt has a population of 116,000 inhabitants. The area excludes the main town, and covers only the county area surrounding the town of Schweinfurt. It is predominantly suburban / rural in nature.

294. In this particular scheme, the switch was not from a system without charging to one with charging, but from one charging scheme to another. Since 1994, the Landkreis had charged households for the disposal of residual waste. The scheme was a subscription based scheme in which households chose the size of container at the beginning of a year and paid according to the size of container chosen. As other studies have suggested, these types of scheme are less likely to be successful at reducing waste significantly since the effect at the margin is limited once the size of container has been determined.<sup>75</sup> Effectively, households are free to make use of the space they have paid for at no additional cost.

295. Before the change in the DVR scheme, a household using a 120 litre bin was charged €170 per annum. The fee covered all the costs of waste management, including fortnightly refuse collection and fortnightly collection of the biowaste container (or “biotonne”). Costs of collecting the materials covered by the system of producer responsibility for packaging were not covered by the municipality. In Germany, these costs are borne by producers, who support the collection system either directly or indirectly under the DSD (Duales Systeme Deutschland) scheme.

296. Because of changes in the law regarding waste disposal, it was expected that without any change to the collection system, the fee for collection would rise to €210 per household. Legislation under the *TA Siedlungsabfall* (Technical Instruction on the Management of Municipal Waste) suggested that only waste with a volatile organic solids content of less than 5% could be landfilled (this was subsequently changed to enable residues from mechanical biological treatment (MBT) to be legally deposited in landfills). The private cost for incineration of waste in the locality was estimated at around €250 per tonne.<sup>76</sup> Hence, a sudden increase in costs of around 25% was being anticipated.

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74. See Eunomia (2003).

75. See, for example, Dijkgraaf and Gradus (2003) and KPMG Bureau voor Economische Argumentatie (2001).

76. This is not untypical of some spot market prices which were being quoted in Germany at the time. Schweinfurt would not have been in a position to procure its own incinerator, or at least, not at a cost which would have been much lower (given the diseconomies of small scale for conventional incinerators).

297. In 1997, the County decided it wanted to take additional steps to reduce costs through reducing the quantity of waste for disposal. They were not keen to change the existing collection infrastructure, but were interested in improving incentives for improved management / reduction of waste by households.

298. The key aims of the change sought were:

1. improved sorting of waste, and reduction in overall waste, leading to reduced residual waste collection;
2. a fairer system of charging; and
3. a reduction in costs (from anticipated levels).

299. The County undertook two pieces of work to understand what might be done:

1. In the first instance, it undertook an analysis of the composition of residual waste. Even though a doorstep collection of biowaste was in place, and this was collecting 110 kg / inhabitant, the proportion of residual waste which was organic waste was estimated at 33%. Paper was also a significant component at 12%; and
2. Secondly, a review of three systems was undertaken:
  - a) Smaller bins;
  - b) Tag scheme (a pay-per bag scheme using pre-paid tags attached to refuse sacks); and
  - c) A weight based scheme.

Of these, the weight-based scheme was deemed most likely to give the greatest reduction in waste.

300. It should be noted that prior to the system's introduction, the quantity of residual waste per inhabitant was already extremely low by international standards at 120kg/inhabitant. This made the system's objectives all the more challenging given the already low level of residual waste in the system.

#### **A.5.2 The charging scheme**

301. The charging system was designed in such a way that on average, householders would pay the same cost after the system's introduction as before. At the end of the trial, some were paying more and some were paying less.

302. The system is based upon a three-part tariff. The three components are:

1. **A fixed fee.** This was intended to cover the fixed costs of the collection infrastructure, including the bulky waste collection, the collection of tyres, fridges, special wastes etc. This fixed element does vary with the size of residual waste bin chosen (the fixed fee is only linked to the refuse bin). For a 120l bin, in 2002, the fee was €8 per month, and for a 240l bin, the fee was €16 per month. The minimum bin size is 120l. It is felt that smaller bins are unlikely to lead to optimised collection of the different fractions.
2. **A fee per emptying of any bin.** The basis for the 'emptying charge' is the amount saved by not emptying a bin. This was calculated as €0.20 per emptying;
3. **A weight-based fee.** This was set at €0.25/kg for residual waste and €0.15/kg for biowaste in 2002.

303. The billing scheme works through an annual invoice, which calculates a bill based upon the previous year's performance by the household. At the end of each year, an adjustment is made to the preceding year's bill based upon the performance of the household relative to the beginning of year estimate. The bill is paid in 4 instalments.

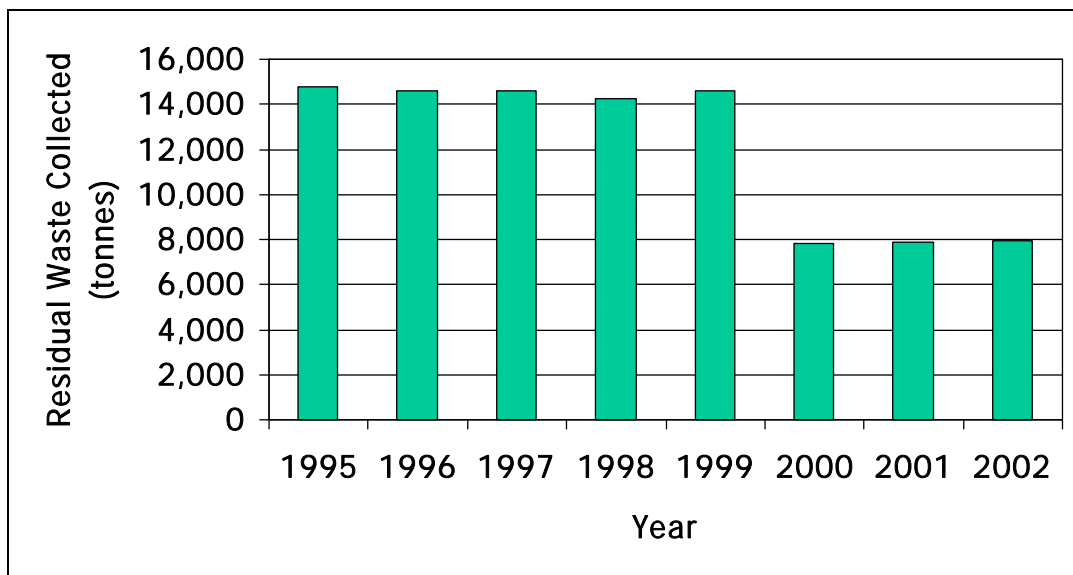
### A.5.3 Effects of the scheme

304. Under the scheme, though collections are only fortnightly, for several bin types, the set out rate is close to 50%. In other words, on average, many householders set out bins approximately once a month. Interestingly, the set-out rate tends to be lower for those using smaller bins. For those using larger bins, the materials tend to be collected approximately once every three weeks. This change in set-out rates has led to reduced staffing levels. The materials are collected on side-loading vehicles, and the pre-scheme situation, in which these were operated with a driver plus one crew, has changed such that now, the vehicles operate with a driver only.

#### A.5.3.1 Residual waste

305. In understanding the effects of the scheme, one must understand the linkages between what has happened to collections at the doorstep, and what has happened at other collection routes. Figure 15 shows the effect of the schemes on the quantities of material collected at the doorstep. The effect is clearly dramatic, with collections falling by more than 40% of the original quantity.

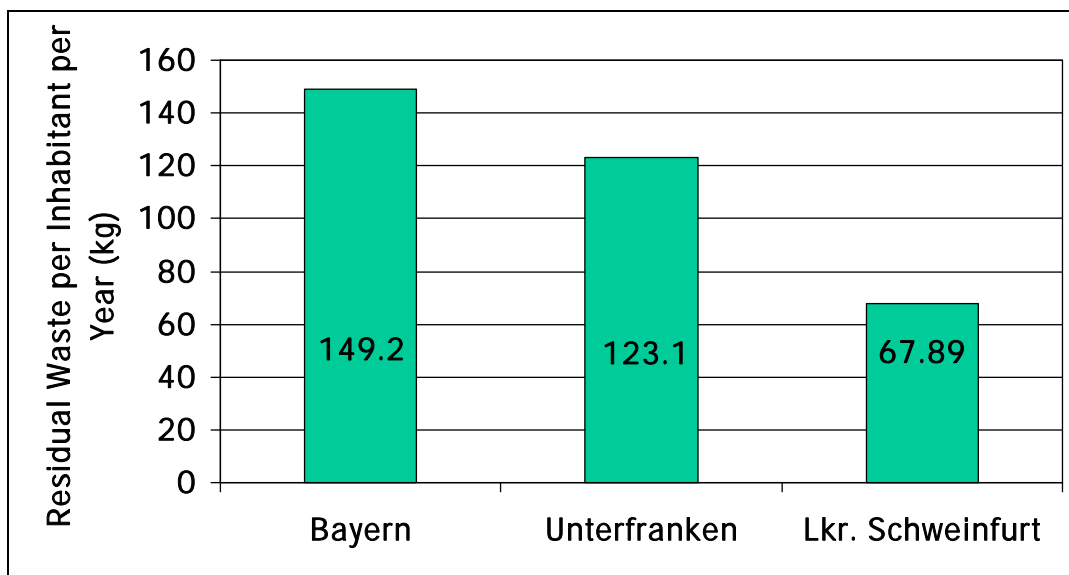
Figure 15. Quantities of residual waste collected through door-to-door collections  
Landkreis Schweinfurt



Source: Landratsamt Schweinfurt

306. Figure 16 clearly shows that this is an exceptional result, even when compared with well-functioning schemes elsewhere in Germany. The change between the pre- and post-scheme situation amounted to a fall from around 14,500 tonnes to around 7,900 tonnes.

**Figure 16. Residual waste collected through door-to-door collection**  
Landkreis Schweinfurt and other areas

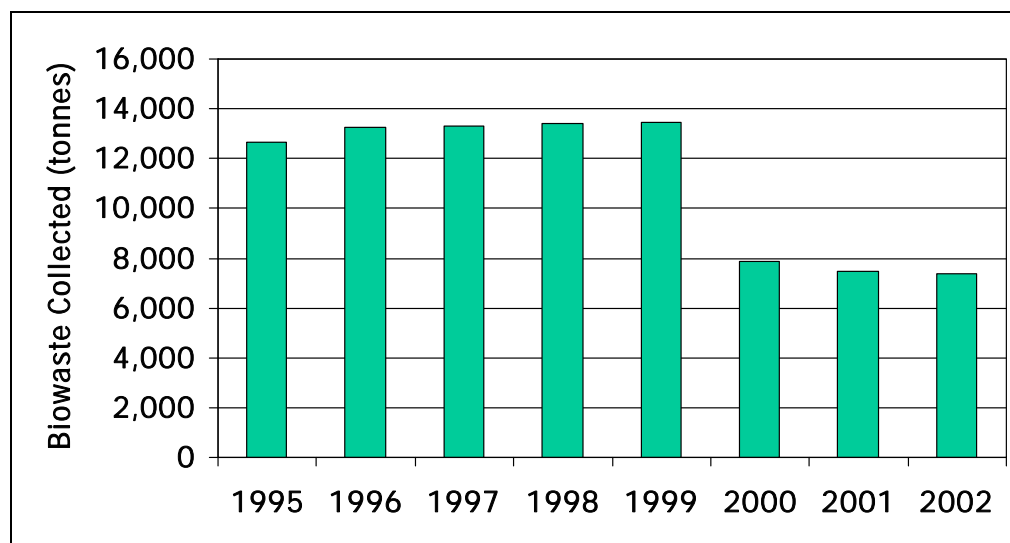


Source: Landratsamt Schweinfurt.

#### A.5.3.2 Separately collected biowaste

307. It might be expected that this decline in residual waste quantities would be explained through an increase in source separation. However, the quantity of material collected through the door-to-door biowaste collection has also dropped by more than 40%. In absolute terms, the fall is from around 13,350 tonnes to around 7,400 tonnes.

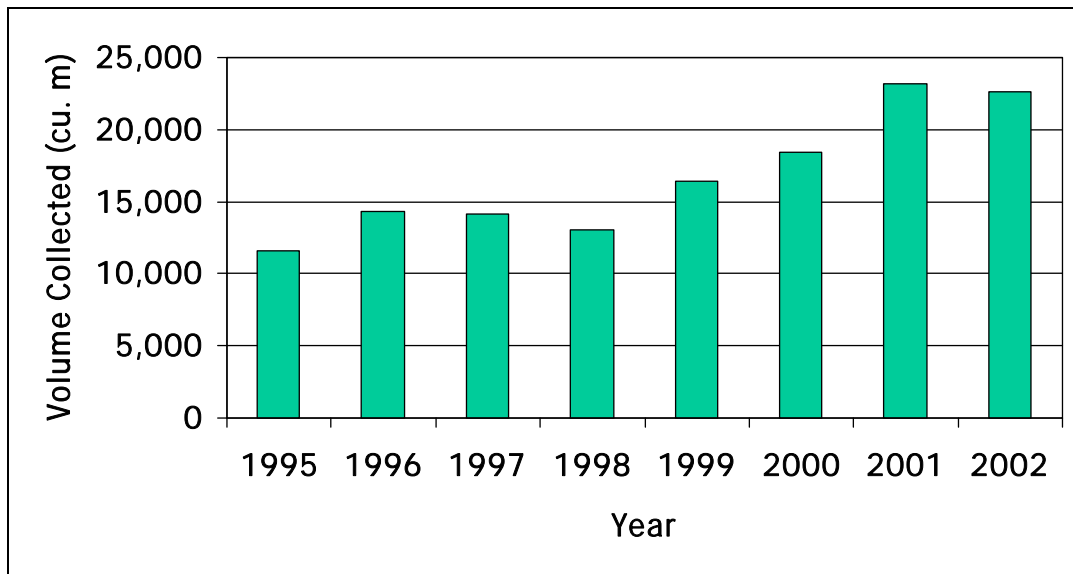
**Figure 17. Biowaste collections, door-to-door system in Landkreis Schweinfurt**



Source: Landratsamt Schweinfurt.

308. Part of the biowaste fraction has simply moved into a different collection outlet. The County operates a network of 29 locations where citizens can bring material from the garden for chipping. There was an increase of around 2,250 tonnes of this material (estimated on the basis of a volume of approximately 9,000 m<sup>3</sup> when shredded). Hence, this does not completely explain the reduction in the quantity of biowaste collected, which suggests an increase in home composting activity and other (possibly illegal) approaches to managing biowaste. A net reduction of around 3,700 tonnes of biowaste still remains.

**Figure 18. Garden material received for chipping at municipal sites in Landkreis Schweinfurt**  
Volume, cubic metres



Source: Landratsamt Schweinfurt.

#### A.5.3.3 Bulky waste collections

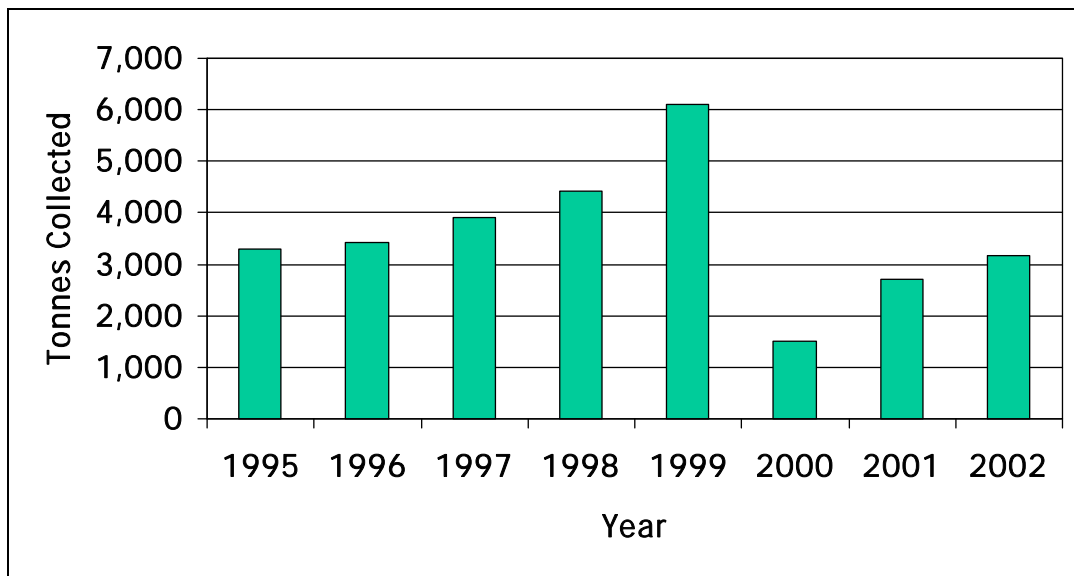
309. The bulky waste collections show the effects of the expectations of a change in the system. The amount collected showed a sharp increase just before the change, and a drop immediately after (see Figure 19). This suggests that many households may have had a major clear-out of bulky items just prior to the scheme's introduction.

#### A.5.3.4 Separate collections (Bring schemes)

310. The county operates a network of 160 mini-recycling centres (bring sites) at which, typically, glass (colour separated), cans and plastics, paper and card, and textiles are collected.

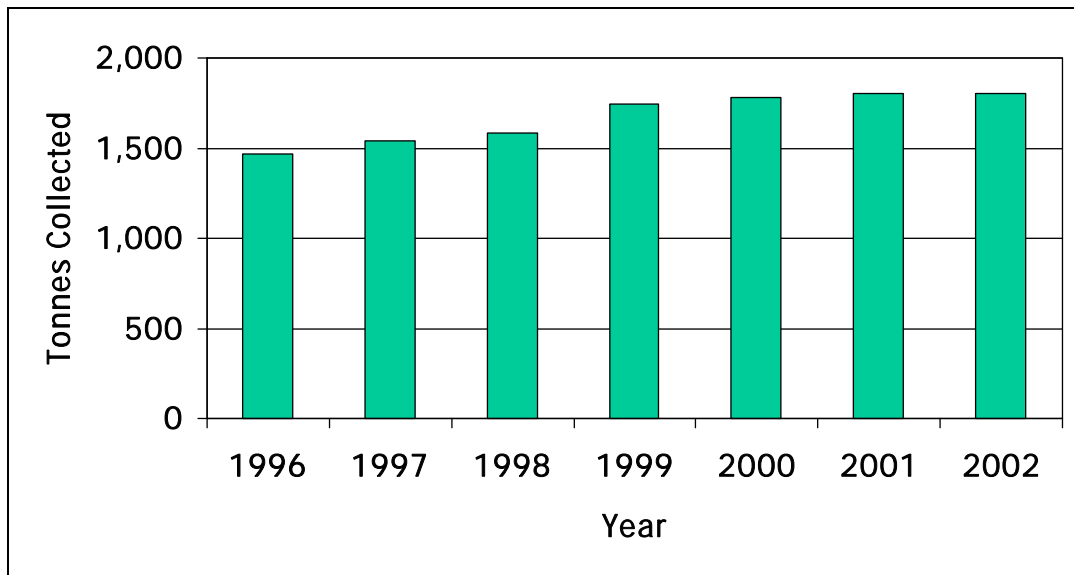
311. Paper collected separately by non-government organisations and through the bring sites increased from around 1,500 to around 1,800 tonnes (see Figure 20). The paper and card sites operated by the local authorities have also seen an increase in recycling from around 4,600 tonnes per annum to 6,350 tonnes per annum (see Figure 21).

Figure 19. Bulky waste collections in Landkreis Schweinfurt



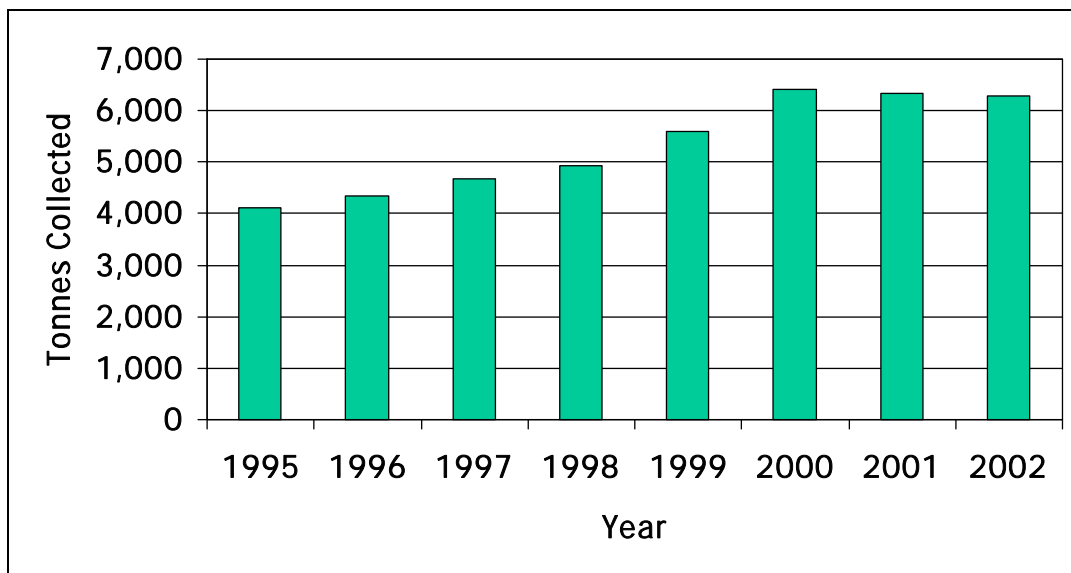
Source: Landratsamt Schweinfurt.

Figure 20. Paper collections through NGO activities



Source: Landratsamt Schweinfurt.

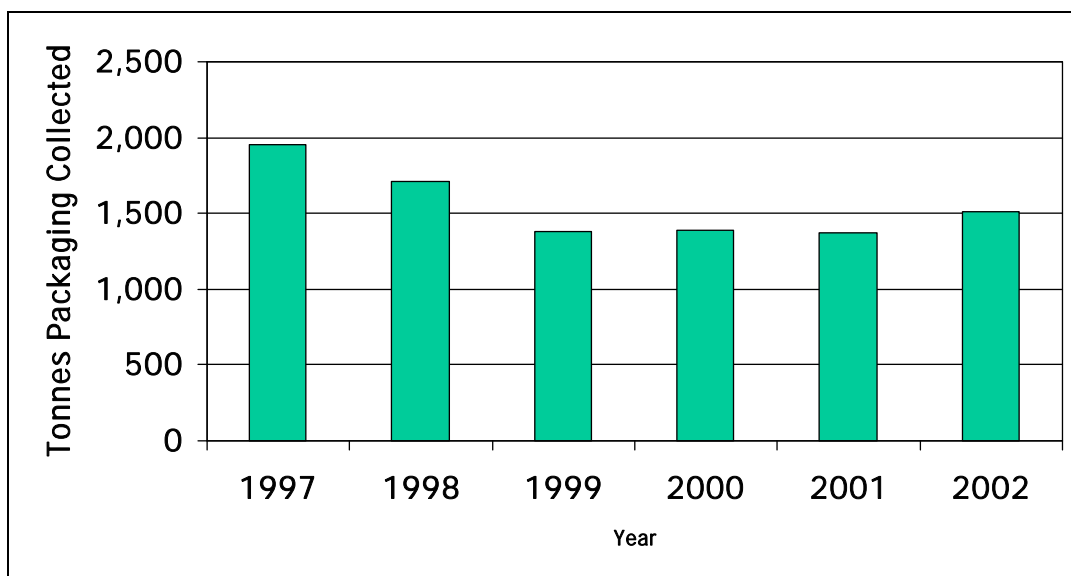
Figure 21. Paper collection through local authority bring schemes



Source: Landratsamt Schweinfurt.

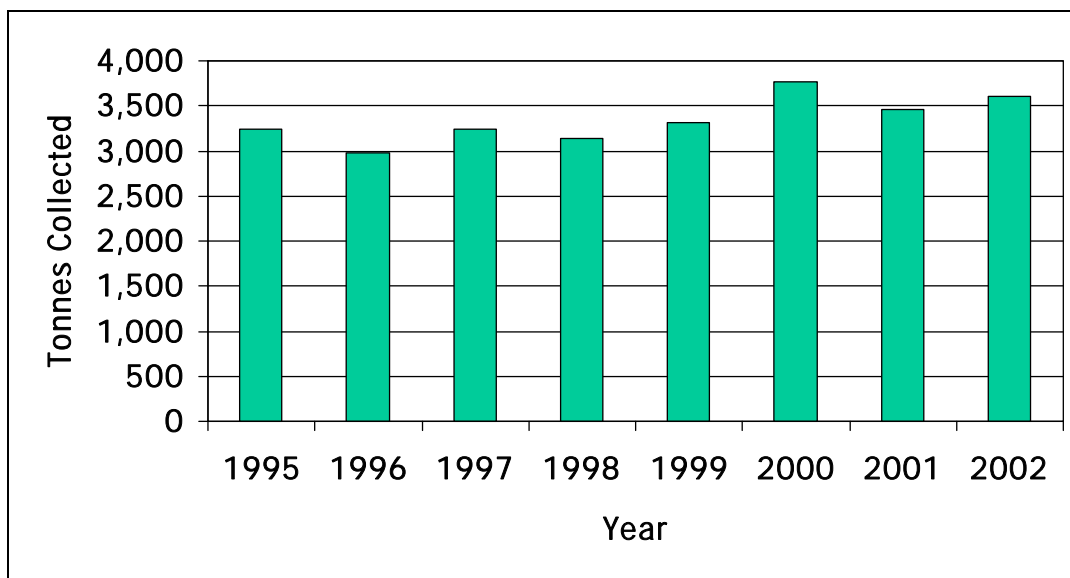
312. The amount of 'DSD waste' (packaging materials) collected has changed very little (see Figure 22), initially falling after the charging scheme was introduced, though this is believed to be due in part to ongoing changes in the nature of packaging placed on the market. Another explanation which seems quite plausible is that the capture of material was increasing (i.e. a greater proportion of material was segregated than previously), but that the overall quantity of material fell as a consequence of changes in purchasing decisions. For bring schemes for glass, some increase – from 3,250 tonnes to 3,600 tonnes – was noticed (see Figure 23). For cans collected through bring schemes, the increase was from around 660 tonnes to 810 tonnes.

Figure 22. Packaging waste (excluding glass) collected (doorstep system)



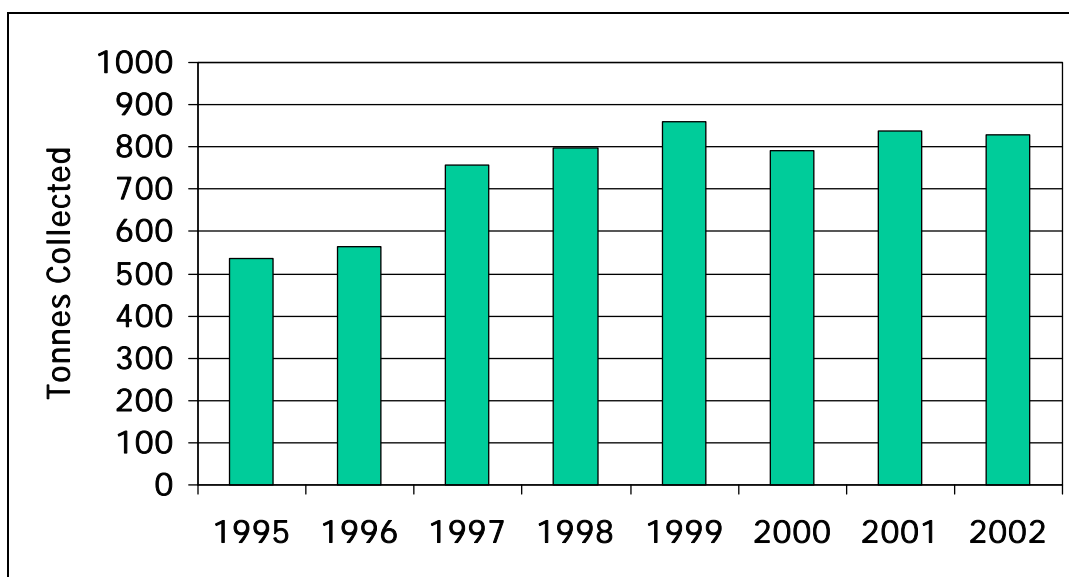
Source: Landratsamt Schweinfurt.

Figure 23. Glass packaging waste collected (bring system)



Source: Landratsamt Schweinfurt.

Figure 24. Cans collected (bring system)

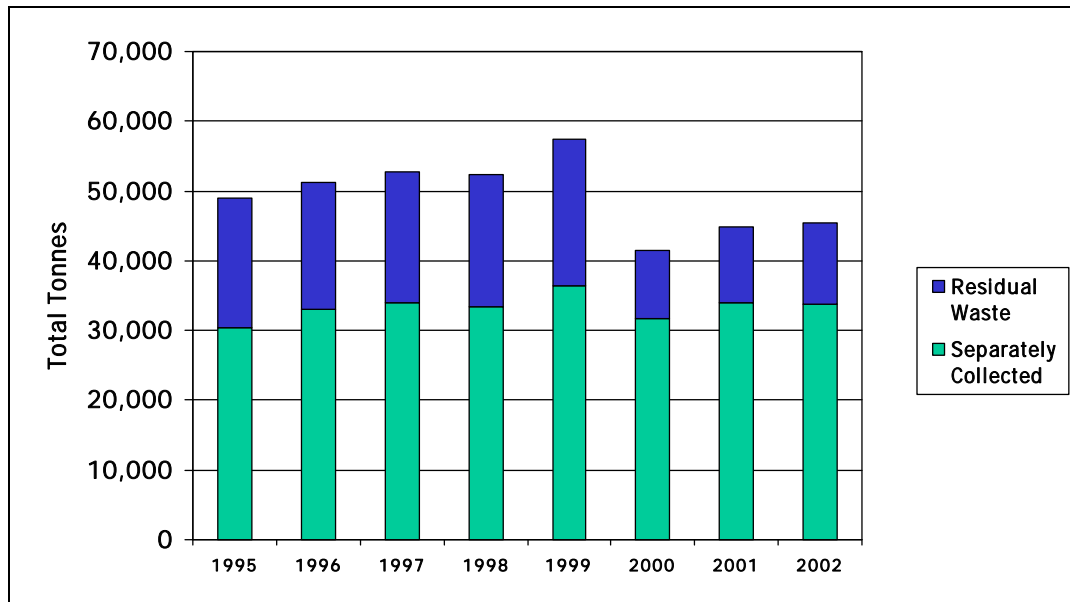


Source: Landratsamt Schweinfurt.

#### A.5.3.5 Net effects

313. The net effect of these changes on the total system for waste management is shown in Figure 25. Between 1999 and 2000, total waste collected fell by 28%. However, this includes the expectations-related effects (in which ‘clean-outs’ occurred prior to scheme introduction). Taking this into account, the reduction was from 52,000 tonnes or so to 45,000 tonnes, a reduction of 13%.

Figure 25. Net effect on waste management system in Landkreis Schweinfurt



Source: Landratsamt Schweinfurt.

314. Residual waste fell from a pre-scheme average of 165kg to a post-scheme average of 92kg per inhabitant, a reduction of 46%. The pre- and post-scheme average recycling rates shifted from 64% to 76%.

315. As regards 'leakage', the municipality states that the issue of contamination has not arisen. Biowaste collections are still above 95% purity. The officers of the municipality also state that the wastage rates from packaging collections are no different from other systems and from the pre-scheme situation.

#### A.5.3.6 Nature of waste reduction

316. After the scheme was implemented, a second analysis of residual waste was carried out to try to understand what the effects of the system had been. Refuse had fallen to marginally more than 50% of what was there previously, but the organic fraction had also fallen significantly in proportionate terms (from 33% to 8% of residual waste). This implied a reduction of around 29% of the *original* residual waste fraction (equivalent to around 60% of the reduction which was observed) due to changes in the way in which the organic fraction was being treated by households. Of course, such analyses cannot be relied upon to provide a completely accurate picture of the changes in quantitative terms, but they suggest a major change in how this fraction was treated. A survey of households was carried out to find out the main reason for the change, and it is believed that increased activity in respect of home composting is the principal explanation for the change.

317. The paper fraction, previously 12% or so of residual waste, fell only slightly in proportionate terms to 11% of residual waste. Yet, bearing in mind the reduction in absolute quantities, the reduction suggests that approximately 6% of the reduction in residual waste was due to changes in householders' handling of the paper and card fraction.

318. The above line of thinking led the County to believe that it could readily explain a 35% drop in residual waste, but that the remaining reduction (the total reduction was 46%) demanded closer

examination. The County considered the possibilities for legitimate and illegitimate changes in behaviour which could explain the 'unexplained' reduction in residual waste.

319. As regards legitimate routes, the following were considered:

1. A reduction in the amount of inert building / DIY waste generated;
2. A change in the use of nappies from disposables to re-usables. Statistics and compositional analysis suggest a reduction from 9.4kg/inhabitant before the scheme to 7kg/inhabitant after implementation; and
3. Consumer choices. Some evidence suggests that consumers are changing consumption habits to reduce the quantity of packaging and / or waste generated.

320. As regards illegitimate changes, the following were considered:

1. Burning of waste by households. Regarding this issue, the County sought information from chimney sweeps. They do not believe this is a major issue, and on past evidence, the representatives of the municipality suggest that if burning did occur in gardens, that neighbours would tend to report such activity;
2. It was suggested that some householders might take their waste to their place of work. Though they consider this a possibility, they have no evidence to suggest it is, or is not, an explanatory factor. The County is inclined not to believe that this is a major issue given the approbation that might follow from peers;
3. Some waste might be flushed into sewers (down toilets), but the County has made checks with water companies and there is no evidence to suggest a change in the nature or quantity of sewage;
4. Fly-tipping is, of course, a possibility. There appear to be two critical places where fly-tipping can occur. One is at the mini recycling centres, the other is litter bins. There was reportedly no evidence of disposal of waste in fields and forests and so forth. The evidence that the County has gathered through its monitoring suggests that clearly fly-tipping happens, but the degree to which there has been a significance increase is not clear. There has been an increase in the number of cases prosecuted. Penalties for illegal tipping were imposed in 54 cases in 1998/1999, and the number increased to 79 in 2000. The attitude of the County is that this is something which happens anyway, it seems that it might have occurred more frequently in the early days of implementation than at present, and that with the support of politicians, the clean up of bring sites will occur more often so as not to attract others to follow suit. It was not possible to estimate the quantity of material cleaned up. On the one hand, there was no pre-scheme data, and on the other, once cleaned up, the waste usually enters the 'formal' system without data being separately recorded.

321. The upshot of the above discussion is that it is not entirely clear how one should account, exactly, for around one sixth of the reduction in residual waste achieved. However, the degree to which this is related to undesirable activities is believed to be small, though clearly not zero.

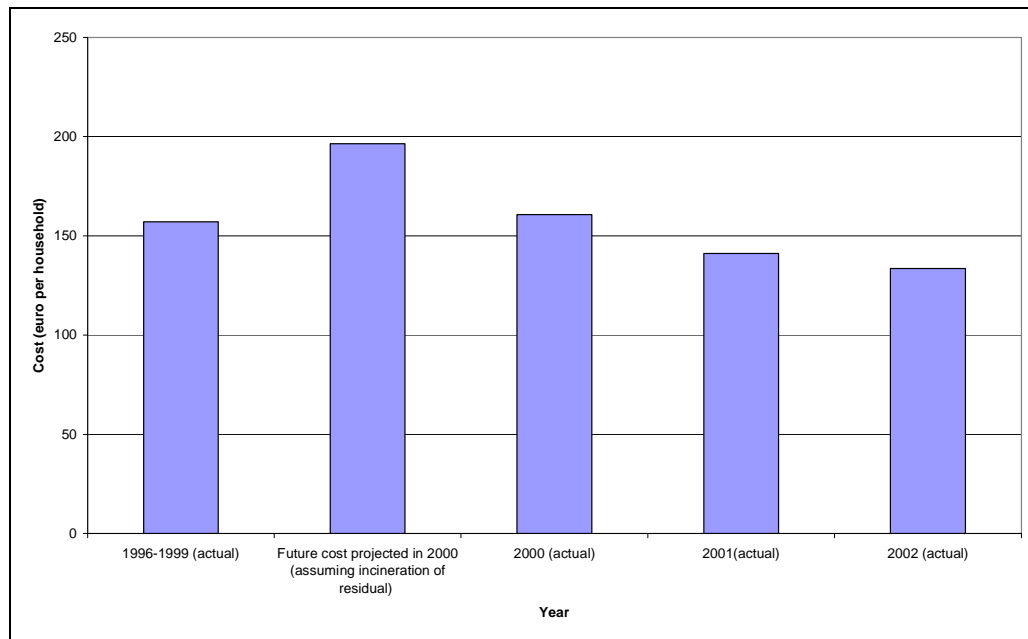
#### **A.5.4 Costs of implementation**

322. The fees per household for those using a 120 litre bin for residual waste and a 120 litre bin for biowaste have evolved as in Figure 26. The costs which have resulted are not only lower than those which were projected, but they were 15% lower in 2002 than costs prior to the scheme's introduction.

323. These are figures which are not adjusted for inflation, so the real cost to householders has probably fallen by approximately 20%. In other words, the scheme has reduced costs. It is important to stress that there are no other sources of revenue for the scheme. The charges paid by households cover all system costs. This includes the costs of monitoring and dealing with illegal tipping.

324. The scheme costs are shown in Table 20 below. As mentioned previously, there are savings on logistics as well as disposal. Furthermore, there have been savings on the costs of invoicing.

**Figure 26. Evolution in average costs for households**  
Households using 120 litre refuse bin and 120 litre biowaste bin



325. Prior to the system’s introduction, each of 29 Councils were paying DM 500,000 for each Council to prepare invoicing. Following the introduction of the scheme, 3 people became responsible for all the invoicing. This saves DM100,000 on invoicing.

326. In total, the analysis suggests savings which are less than is suggested by the analysis for the households using 120l bins above. It should be remembered, however, that the household analysis above is based on one type of system user only, whereas the cost data refers to aggregate figures. The estimated saving is close to €6 per household per annum.

**Table 20. Annual costs and savings relative to pre-scheme situation**

	Change in Costs (€)	Costs (approx. €/per household)
System cost (hardware, software and containers)	€ 375,000	€ 8.08
System cost (variable elements)	€ 227,500	€ 4.90
Administration	€ 150,000	€ 3.23
Reduction in amount of refuse	-€ 915,000	-€ 19.72
Lower set-out	-€ 90,000	-€ 1.94
Savings on administration	-€ 245,000	-€ 5.28
Reorganising bulky	€ 150,000	€ 3.23
Fly-tipping (monitoring)	€ 71,000	€ 1.53
Costs	€ 973,500	€ 20.98
Savings	€ 1,250,000	€ 26.94
<b>Costs Net of Savings</b>	<b>-€ 276,500</b>	<b>-€ 5.96</b>

### A.5.5 Assessment of benefits

327. It has not been possible to calculate all relevant costs and benefits. In the assessment below, we have assumed – so as to be conservative in the estimate of benefits – that of the observed reduction in refuse, 2,000 tonnes does not constitute ‘genuine routing away from landfill’. There is, as discussed above, no clear reason to believe that dumping has increased significantly, but we have assumed that this figure increased by 500 tonnes following the scheme’s introduction, and that 1,500 tonnes move back to the commercial waste stream. This may understate the true extent of waste reduction.

328. Those benefits which have been calculated suggest benefits of between €8 to 16 per household (see Table 21). These are significant benefits and, as with the case of Torelles de Llobregat, they seem unlikely to be offset by negative externalities associated with illegal disposal because of their magnitude.

**Table 21. Net external costs and benefits of the change in Landkreis Schwerfurt**

	Mass Effect (tonnes)	External Benefit (low damage costs)	External Benefit (High damage costs)
Residual Waste	-5,528	€ 53,143	€ 247,361
Dry Recyclables	-200		
Paper and Card	2,050	€ 94,011	€ 193,057
Packaging	-100	-€ 9,274	-€ 20,812
Glass	350	€ 3,979	€ 15,662
Steel	128	€ 6,892	€ 12,536
Aluminium	23	€ 13,956	€ 37,481
Old Tyres	0		
Hazardous Waste	-26		
Compostables	-5,950	€ 82,306	€ 306,340
Chipping stations	2,250	-€ 31,124	-€ 115,843
Reduction	8,854		
Home Composting	3,700	-€ 96,200	-€ 210,900
Waste Reduction	934	€ 270,959	€ 270,959
Illegal	500	n.i.	n.i.
Re-routing to commercial waste	1,500	n.i.	n.i.
<b>TOTAL EXTERNAL BENEFITS</b>		<b>€ 388,649</b>	<b>€ 735,842</b>
<b>EXTERNAL BENEFITS PER HOUSEHOLD</b>		<b>€ 8.38</b>	<b>€ 15.86</b>

n.i. = no information

329. In the Schweinfurt case, estimating any additional costs of time spent in recycling is not so straightforward, and perhaps less necessary. The Schweinfurt kerbside collection system is far more comprehensive in its materials coverage than the Torelles de Llobregat system. The principle material

which is not targeted by the scheme for collection at the kerbside is paper and card. Perhaps unsurprisingly therefore, paper and card collections through bring sites increased following the scheme's introduction.

330. In total, bring site collections increased from 10,670 tonnes to 13,370 tonnes. Of the 2,700 tonnes increase, 2,050 tonnes were paper and card and 350 tonnes were glass. There are 160 sites collecting such materials in Schweinfurt. Given such a density of sites (one every 725 inhabitants), it seems quite reasonable to assume that few 'dedicated' journeys to those sites would need to be made, and that most drop-offs could be made on the way to a different destination. We have not, therefore, estimated a cost associated with this time in this case since we believe it would be rather insignificant.

#### **A.5.6 Summary of costs and benefits**

331. This scheme gave rise to a reduction in costs of the order €6 per household. This includes the costs of monitoring and enforcement of fly-tipping, of which there has been some increase. The costs to the municipality do not include the costs of collecting packaging materials since these are borne by the DSD system. However, in this case, the packaging collections have not increased significantly other than at bring sites which are the least expensive service for contractors to run. Consequently, the costs of service provision have probably changed relatively little.

332. The benefits are potentially considerable, and probably no less than €8 per tonne. The net social benefits, therefore, appear to be no less than €14 per household before accounting for illegal activity.

333. We have not included any estimate of additional time for sorting waste for recycling. In this particular case, the principal increase in the quantity of material being recycled relates to the paper fraction. This does not require additional washing and the dense network of bring sites makes it far less likely that households make significant additional journeys to take materials for recycling.

334. In this particular case, the municipality has made considerable effort to understand the exact nature of the waste reduction. Our view is that this is unlikely to be the source of the reduction and that other factors – efforts in waste reduction and re-use, changes in consumption patterns, and, possibly, a move of commercial waste away from the municipal stream – are likely to have been important.

## ANNEX 6: CASE STUDY 3 – GHENT AND DESTELBERGEN (FLANDERS, BELGIUM)

335. This study is based upon work initially carried out by the author elsewhere, with the assistance of operators from IVAGO.<sup>77</sup>

### A.6.1 Background

336. IVAGO is a company set up 1 January 1995 with 50:50 share ownership split between the city of Ghent (and a smaller community, Destelbergen) and the 3 private partners Indaver (Vlar), Watco and Seghers Better Technology.

337. The two areas – Ghent and Destelbergen – cover a range of different types of dwellings and housing density. For example, the city of Gent, with 224,000 residents, is spread over an area of 7,000 ha and is subdivided into 3 area types:

- Central area, including all apartment buildings up to 10 individual apartments (136,091 residents).
- Large apartment buildings with more than 10 individual flats (24,834 residents or 17,880 families).
- Rural areas (88,409 residents or 34,768 families)

338. This provides context for the design of the services and the associated charging scheme (as will become clear below).

339. The context for IVAGO's work is provided, to a significant degree, by OVAM (the Flemish Environmental Agency). OVAM issued a Plan of Execution for Household Waste for the period 1997-2001. This plan became the backbone of the waste strategy for the region of Flanders and included the following targets:

1. *Prevention* : the objective for 2001 was 6% of total household waste collected in 1995;
2. *Increase recycling / reuse* from 34 % in 1995 up to 52 % in 2001.
3. *Increase the rate of source separation* from 22 % in 1995 to 45 % in 2001. This means that the total amount of household waste separately collected had to increase from 70 kg to 120 kg per resident.
4. *Residual waste per inhabitant* was to decrease from 325 kg in 1995 down to 255 kg in 1998 and 240 kg in 2001.

340. Residual waste is termed 'refuse waste' in Flanders and is defined as the total of:

- collected refuse waste door-to-door
- bulky household waste (furniture, metal scrap, refrigerators, TV's, plastics,...)
- community waste (street cleansings, public waste bins, ...)

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77. See Eunomia (2003).

### A.6.2 Pre-scheme situation

341. To cover environmental expenses most cities and communities had operated a system of fixed charges per household, or a system of indirect taxes related to householder income. The city of Ghent had no environmental or household tax rate as such.

342. This meant that the total cost of waste management for the city of Ghent had to be covered by general revenues the city derived from all other tax systems. IVAGO was receiving, and still receives, a monthly contribution from the city to cover its costs. However, this budget was frozen in 1995, and in 2003, the total amount received in was actually reduced by €1.1 million to €25.9 million, despite inflation, salary increases and so forth. Hence, the service was, until the introduction of the DVR scheme, free at the point of collection for householders.

343. Between 1994 and July 1998 (the start of the DVR charging scheme, or Diftar system in Flemish) a variety of systems were introduced, step by step, in order to pave the way for the DVR charging scheme's introduction.

1. The old "bucket" style receptacle was replaced by a 60 litre plastic bag for residual waste;
2. From 1996 PMD (plastic bottles, metal and drink packages) were collected in a transparent blue sack, once every month;
3. In the rural areas, from 1996, collection of organic solid waste, once a fortnight, was started. Initially, a special fee was charged to the resident, but this was discontinued;
4. Glass was traditionally collected door-to-door (for more than 20 years free of charge);
5. The residual waste fraction was collected fortnightly. The residents paid 8 BEF (0.2€) per sack.

### A.6.3 Rationale for scheme introduction

344. The city of Ghent was the first city in Flanders to introduce (as of mid 1998) a system which made a direct link between the amount of waste generated by a family and the money they had to pay for it. The principle rationale for this was to make 'polluters pay'.

345. The aims of the system – which went beyond the targets set by OVAM – were as follows:

1. Reduce the amount of waste produced and maximise recycling and reuse of waste materials where practical;
2. Reduce total refuse waste from 325 kg per resident in 1995 to 165 kg in 2000;
3. Increase selectivity from 31 % to 50 % by year 2000;
4. Control the impurities on selective fractions to agreed levels. For example, for the packaging fraction (called 'PMD waste' – plastics, metals and drinks cartons): less than 20 % impurities;<sup>78</sup>
5. Keep the total quantity of household waste below 500 kg per resident per year;
6. Increase the number of household waste sites (civic amenity sites) so there is a maximum coverage of the territory (in principle one site for each 25,000 residents);
7. Reduce the financial contribution of the city of Ghent by €7.5 million (or 30%); and

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78. PMD is the term for plastic and metal drinks containers in Flanders.

8. Create awareness of the costs of waste management through direct charging of residents according to the costs of collection and waste treatment of different materials.
346. The City decided that a number of other factors needed to be considered. Those identified by the City as important were as follows:
- that because, by charging residents for their waste, incentives for evasion would be created, illegal behaviour such as fly-tipping should be severely punished. This would require new measures to be put in place;
  - that social corrections (for poorer households) would have to be possible in the system;
  - that there would need to be equality of treatment, in the costs of the service, between the residents of the rural area and the residents of the city centre;
  - that only a proportion of the costs for refuse, organic solid waste and packaging fraction would be recovered through the charging system;
  - that the charge would be set as low as possible, consistent with achieving the objectives set by the municipality;
  - that there should be a difference in the charging rate between that for refuse and that for organic solid waste which would be sufficient to stimulate separation, but not so high as to compromise the quality of the organic waste collected. If the price difference was too high, it was suggested that there would be a risk that too much refuse would find its way into the organic waste bin;
  - that an appropriate solution for apartments should be found by which each resident would become individually responsible, as well as financially responsible, in relation to the prevention of waste and the behaviour towards source separation. In each apartment where waste chutes existed, these would need to be firmly closed;
  - that complaints and abuses should be minimised;
  - that all existing services (including the frequency of collecting waste) should be maintained, especially in an initial stage;
  - that the legality of the charging model would need to be established. The way IVAGO is structured, it is not allowed to invoice the residents directly because of the complexity of fiscal and juridical laws. The city itself would have to collect the money via a 'retribution' system approved by the council; and
  - that progressive extension should be made possible.
347. It was agreed that the project would be introduced on 1/7/98.

#### **A.6.4 Charging system used**

348. As previously mentioned, for the purpose of the provision of waste services, Ghent and Destelbergen are divided into three areas, the central area, apartment buildings and the rural areas. The designation determines the type of receptacle to be used by the residents, i.e. whether they use a sack or a waste bin. The residents cannot choose whether they use sacks or bins – this decision is made for them as the whole door-to-door collection system is designed to match the type of receptacle used.

349. The central area uses only sacks for refuse and biodegradable sacks for organic waste. At large buildings, residents are asked to use the sacks and then put them in a large trolley bin. The rural area has only wheeled bins, one for residual waste and one for organic waste. All the bins are equipped with an IntelliGhent "chip". All areas make use of the same transparent blue sack for packaging materials.

350. Table 22 below shows the different tariffs applied for bins and sacks in rural and urban areas. The charges can only be collected by the treasury department of the city of Gent. All rates have to be approved beforehand by the council. IVAGO is responsible for the technical specifications (sacks, bins) but it is the

city of Ghent who purchases the containers from different suppliers. IVAGO also takes care of the distribution of sacks and waste bins.

351. The residents in the centre of Ghent buy – from one of the 350 distribution centres (shops, etc.) - the relevant waste sack. Waste sacks, packed in rolls of 10 or 25, are purchased at a fixed rate (no discounts are granted). The storekeeper receives a small fraction of the sales price (1 to 2 %). The service he/she is offering will enable the storekeeper to attract people who will buy other goods as well.

352. The residents in the rural area are obliged to use containers and pay in advance in accordance with the size of the container for 18 ‘emptyings’. Waste bins, one for residual waste and one for ‘meat-excluded’ organic waste (i.e. kitchen and garden waste), are supplied free of charge to each resident in the rural area of Gent. The bin has a unique intelliGhent chip which registers each individual emptying of the bin. It is automatically read by a reading device mounted, at the back, on the loading system of the truck. Data (customer name, address, type & size of container) are registered in the chip and fed to the RAM-disk on the on-board computer in the truck. At the end of the day the driver presents the RAM-disk to the central computer system at IVAGO. Data are sent by modem to an outside service company who processes the data. A new request for payment is issued automatically when the ‘credit’ remaining has reached a specific level (6 emptyings). The system is fully automatic and does not allow human interference. The waste bin cannot be emptied if the resident has not paid in advance (since the chip on the bin is read as it is loaded on the vehicle, and the bin lift will not function if the householder has used up all credit) so there are no bad debtors in the system.

353. Of the total costs for collection and processing / treatment / disposal, approximately 20% are met by the charges paid for sacks and emptyings of bins.

**Table 22. Structure of charging system applied in Ghent**

Type of waste	Recipient	Volume	Price in €
Refuse waste	Sack	15 l	€0.37 per sack
		30 l	€0.62 per sack
		60 l	€1.24 per sack
	Waste bin	40 l	€0.87 per pickup
		60 l	€1.24 per pickup
		120 l	€2.48 per pickup
		240 l	€4.96 per pickup
Biowaste	Biodegradable Sack	15 l	€0.25 per sack
		30 l	€0.50 per sack
	Waste bin	40 l	€0.62 per pickup
		60 l	€0.99 per pickup
		120 l	€1.98 per pickup
		240 l	€3.97 per pickup
Non-glass packaging (PMD)	Blue sack	60 l	€0.12 per sack
Paper/cardboard	-	-	No charge
Glass	-	-	No charge

Note: Where bins are concerned, the price is ‘per emptying’ of the bin. Residents choose the frequency with which they ‘set out’ their bin for collection. Each pick up is registered on the intelliGhent chip.

#### **A.6.5 Effects of scheme and service changes**

354. Table 23 and Table 24 show the evolution of waste arisings and their destination in Gent. One notes, from the Tables, the continuing rise in source separation rates. Also of note is the way in which the separate collection of organic waste (OSW), collected on a door-to-door basis, has dropped slightly (following the (re-)introduction of a charge for its collection). At the same time, garden waste collections (at the container-park s) have continued to increase. This suggests that because the network of sites is relatively dense in the area, householders have been incentivised by the charging scheme to carry a

growing proportion of their waste to the sites. Lastly, and significantly, there has been a major increase in the quantity of waste flowing through the well-organised container-parks, which selectively collect a very large number of waste fractions. This incurs some cost on the part of the householders themselves.

**Table 23. Effects on waste production in Ghent**  
Tonnes, unless otherwise indicated

	1995	1996	1997	1998	1999
<b>Total refuse (1)</b>					
Door-to-door	68,967	58,220	49,396	35,824	31,426
Bulky waste	4,466	10,846	10,468	10,874	8,663
Street cleansings	1,252	1,500	1,600	1,651	2,271
<b>TOTAL</b>	<b>74,685</b>	<b>70,566</b>	<b>61,464</b>	<b>48,349</b>	<b>42,360</b>
Kg per resident					
Door-to-door	300	253	219	160	140
Bulky waste	19	40	46	49	39
Street cleansings	6	7	7	7	10
<b>TOTAL</b>	<b>325</b>	<b>300</b>	<b>272</b>	<b>216</b>	<b>189</b>
<b>Separately collected (2)</b>					
Tonnes	30,954	36,764	47,598	58,701	66,941
Kg per resident	135	160	211	261	299
Percentage %	31	35	44	55	61
<b>Total household waste (1+2) (Tonnes)</b>	<b>105,639</b>	<b>105,830</b>	<b>107,463</b>	<b>107,050</b>	<b>109,301</b>
<b>Kg per resident</b>	<b>460</b>	<b>460</b>	<b>475</b>	<b>477</b>	<b>487</b>

**Table 24. Selectively collected waste fractions in Ghent**  
Tonnes

	1995	1996	1997	1998	1999
Demolition waste	6,928	11,843	11,008	13,215	14,992
Paper/hardboard	9,564	9,140	10,613	13,374	15,583
OSW	-	1,639	11,666	11,047	9,186
Garden green waste	7,208	5,539	4,759	6,484	8,372
Glass	5,948	5,833	5,585	6,397	6,672
Metal	978	2,271	2,264	2,457	2,731
Electric & Electronics	12	20	200	304	373
PMD	108	156	277	2,828	3,707
Wood	-	-	-	1,218	3,652
SDW (small dangerous waste)	155	204	294	367	435
Others	53	119	934	1,012	1,237
<b>TOTAL</b>	<b>31,007</b>	<b>36,883</b>	<b>47,598</b>	<b>58,701</b>	<b>66,941</b>

355. The effects of the scheme have been significant, though it is difficult to dissociate these from the other changes in the collection scheme being implemented on an ongoing basis. However, discussions with those responsible for the service suggest they believe that the charging system is an important component of the overall service. The fact that it is difficult to estimate the effects of the charging scheme in isolation merely reaffirms the view that charging ought to be considered alongside the provision of carefully designed services.

#### A.6.6 Illegal dumping

356. Before introducing the system, no adequate reporting system was in place for illegal tipping. Today an estimated maximum of 0.5% of total household waste is thought to be illegally tipped. According to IVAGO, the major problems occur around, and in, large buildings, and in some areas with low income residents. There is no easy way of characterizing the type of person who is the "fly tipper".

Our own visits to the scheme suggest that at apartment blocks, there is also a significant amount of waste leakage, with refuse being disposed in sacks for PMD waste. This varies significantly across apartment blocks, a key variable being the supervision of the apartment block attendant. Where the attendant takes a positive interest in the scheme, the trolley bins are clean, and the material is far less contaminated than in the case where the communal area is left to deteriorate, attracting increasing quantities of dumped materials.

357. It is also thought to be unavoidable that some commercial waste will be found in the household waste stream. As a rule, in Gent, small companies may present up to 3 bags. IVAGO also collects commercial waste (similar to household waste) on a contractual base (about 4,000 customers). Problems persist due to some (small amounts of) 'black market' money (and other 'benefits in kind') for the waste collectors themselves.

#### **A.6.7 Private costs**

358. It is not straightforward to compare costs before and after the start of the system. There were too many changes in logistics and service levels which took place alongside the charging system. As stated before, the residents only pay directly 20% of the total cost for the collection and treatment of all waste fractions. The residents pay on an account number of the city of Gent. IVAGO receives a monthly contribution from the city to cover all costs.

359. To compare costs, one must also consider the service on offer. Politicians want to increase service performance continuously, but this can have a significant impact on cost. For example, if IVAGO was to collect organic solid waste every week (instead of every fortnight), it is estimated that this would cost an additional €1 million annually (investment in extra lorries, staff, etc.).

360. If one compares the period before 1998 and the period after, one sees a continuation of the improvements made in separate collection (see Figure 27), a continuous increase in waste delivered to bring sites, and – in the year 1998 – a slight constraint on overall growth of waste arisings (though this is barely discernible, and could not be assumed to be statistically significant) (again, see Figure 27).

361. If one attributed the changes between 1997 and 1999 entirely to the charging system, one finds the changes as in Table 25. These are figures from IVAGO, adjusted for calculations of changes.

Figure 27. Evolution of system performance in IVAGO area

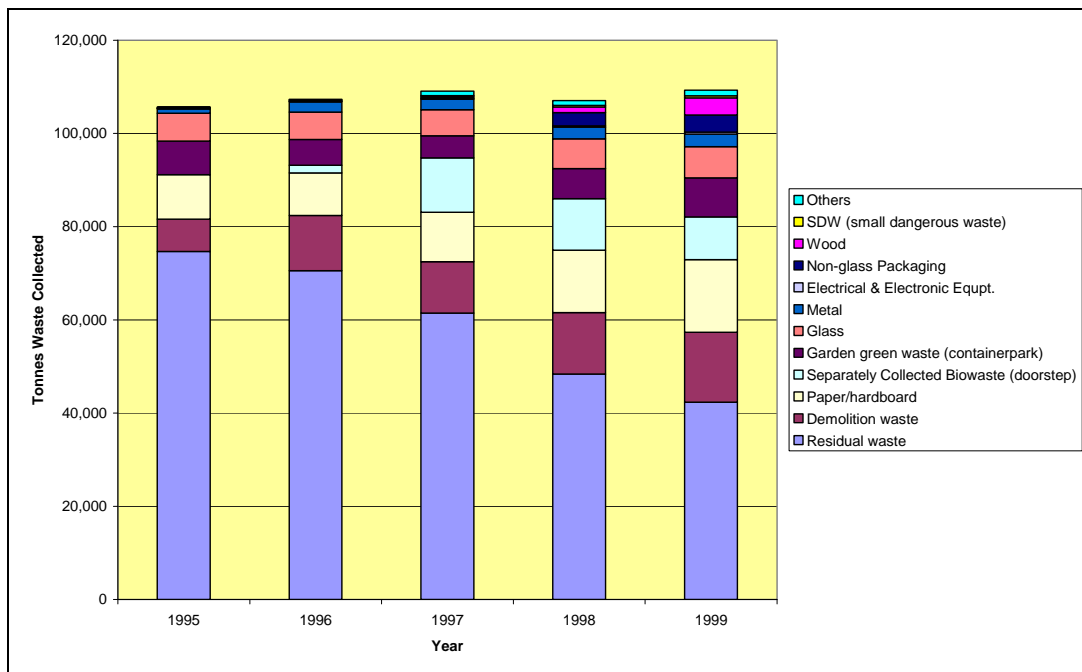


Table 25. Changes in material flows, Ghent  
1997-1999

Material	Change in Quantity (tonnes, 1999-1997)
Residual waste	-19,104
Separately Collected Fractions	
<i>Demolition waste</i>	3,984
<i>Paper/cardboard</i>	4,970
<i>OSW</i>	-2,480
<i>Garden green waste</i>	3,613
<i>Glass</i>	1,087
<i>Metal</i>	467
<i>Electric &amp; Electronics</i>	173
<i>PMD</i>	3,430
<i>Wood</i>	3,652
<i>Household hazardous waste</i>	141
<i>Others</i>	303
Total Waste	1,838

**Table 26. Total costs, savings and revenues of the DIFTAR system in Ghent**  
Annual figures

	€ per annum	€ per household per annum, approx
<b>ADDITIONAL COSTS</b>		
<i>Operation of DVR system (third party)</i>	€ 700,000	€ 6.09
<i>Additional in-house administration and follow up of container changes (4 people)</i>	€ 150,000	€ 1.30
<i>Depreciation on containers</i>	€ 350,000	€ 3.04
<i>Clean up from illegal evasion of the charge system</i>	€ 300,000	€ 2.61
<b>CHANGE IN COSTS OF TREATMENT</b>		
<i>Reduction of 19,104 tonnes residual waste</i>	-€ 2,300,000	-€ 20.00
<i>Reduction of 2,400 tonnes organic waste</i>	-€ 200,000	-€ 1.74
<i>Increase of 3,613 tonnes garden waste</i>	€ 108,390	€ 0.94
<b>LOGISTICS SAVINGS</b>		
<i>Fewer staff and trucks (changes in set-out frequency)</i>	-€ 600,000	-€ 5.22
<b>TOTAL IMPLEMENTATION COSTS</b>	<b>€ 1,500,000</b>	<b>€ 13.04</b>
<b>IMPLEMENTATION COSTS NET OF LOGISTICS SAVINGS</b>	<b>€ 900,000</b>	<b>€ 7.82</b>
<b>CHANGES IN TREATMENT COSTS</b>	<b>-€ 2,391,610</b>	<b>-€ 19.80</b>
<b>TOTAL COSTS NET OF SAVINGS = 1</b>	<b>-€ 1,491,610</b>	<b>-€ 12.97</b>
<b>INCOME FOR TREASURY FROM CHARGES = 2</b>	<b>€ 5,400,000</b>	<b>€ 46.96</b>
<b>NET EFFECT ON REVENUES = (2-1)</b>	<b>€ 6,891,610</b>	<b>€ 59.93</b>

362. Table 26 shows that system net cost reductions are of the order €13 per household. This is strongly dependent upon one's view as to whether the changes over this period are attributable solely to the charging system, or whether the benefits derive also from system changes which are independent of charging.

363. If one assumes that 50% of the change in treatment costs is due to the DVR system, but all of the costs and logistical savings are attributable to the charging system, the savings net of costs fall to €2.08 per household. If one attributes only 25% of the change in treatment costs to the scheme, then net costs of €2.87 apply.

364. The revenues from the charging system augment the net savings, such that the net effect of the system, in the context of the budgetary situation, has been to increase the budget available for other activities by almost €7 million. This is not relevant for the assessment of costs and benefits, and simply represents a change in the distribution of costs.

365. Table 25 does not show the additional costs which might be attributed to increased outlays on the recycling collections, though it is worth noting here that in Flanders, to the extent that collections increase, the payments made by the organization in charge of compliance with the Packaging Directive makes payments to municipalities on the basis of materials collected. Similarly, Producer Responsibility-type mechanisms applied to other materials (the BEBAT scheme for batteries, for instance) can enable local authorities to generate revenue streams from materials collected separately at container-park s.

366. If these costs were included, it might be the case that the increase in the collection of packaging would actually indicate that the cost savings are not as great as they are shown here. Certainly, in the UK, where changes from fortnightly collections to weekly ones occasion an increase in capture of materials, costs for such a change tend to be of the order €5-6 per household per annum. Consequently, inclusion of these figures may make the picture regarding costs somewhat less positive than it has been presented here. This is especially true since the PMD fraction consists principally of low density packaging materials. Even if these are assigned a relatively high cost of around €300/tonne for collection, then the additional

cost for the whole system would still remain negative since the per household cost of this increased collection would be of the order €10 per household.

#### A.6.8 External costs and benefits

367. If one uses the same material flows as those discussed in Table 25 above, the external costs are as calculated in Table 27. We have calculated these assuming that the scheme is responsible for all the change, for 50% of the change, and for 25% of the change.

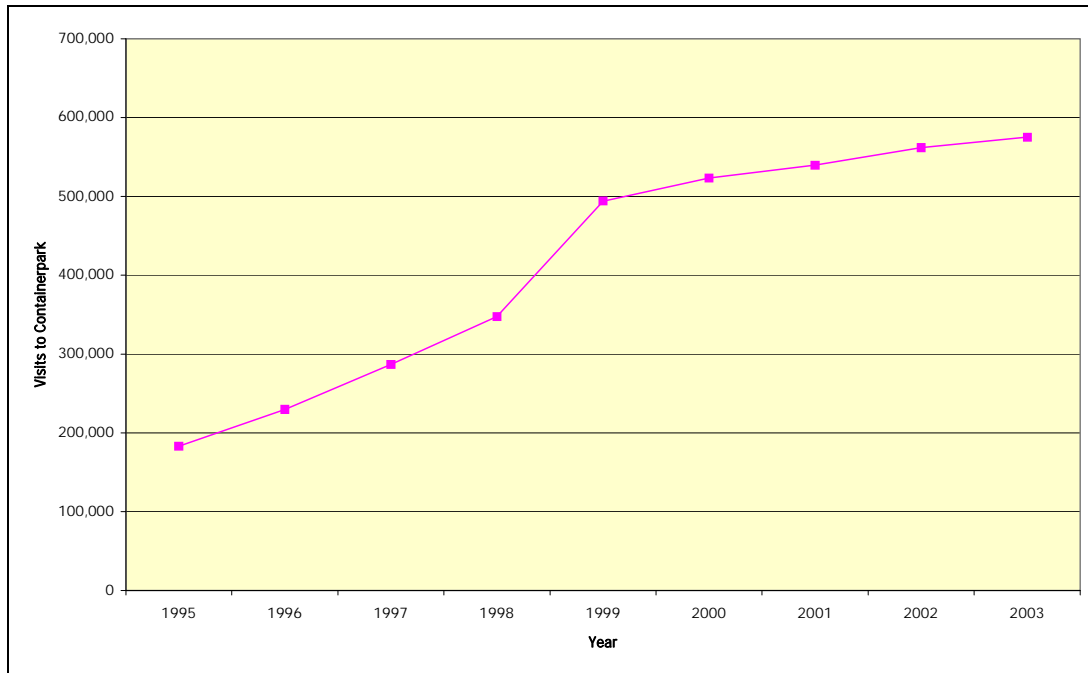
**Table 27. External benefits and costs of the scheme in Ghent**

Waste Stream	Tonnage Change	External Benefit (low damage costs)	External Benefit (high damage costs)
Residual Waste	-19,104	€ 619,944	€ 1,199,168
Paper and Card	4,970	€ 227,920	€ 468,045
Glass	1,087	€ 12,357	€ 48,643
Steel	1,925	€ 104,047	€ 189,248
Aluminium	257	€ 159,567	€ 428,537
Plastics	1,715	€ 79,729	€ 141,990
Inerts	3,984	€ 11,554	€ 11,554
Compostables	1,133	-€ 15,673	-€ 58,333
<b>Total External Benefits</b>		€ 1,199,445	€ 2,428,851
<b>External Benefit per Household Assuming 100% effect</b>		€ 10.43	€ 21.12
<i>Assuming 50% effect attributable:</i>		€ 5.21	€ 10.56
<i>Assuming 25% effect attributable:</i>		€ 2.61	€ 5.28

368. In this case, there are no benefits attributable to recycling of wood, or to recycling of other items such as waste electrical and electronic equipment.<sup>79</sup> On the other hand, no disbenefits have been attributed to the waste which is illegally disposed of. This is believed to be low in quantity (around 0.5% of total, or around 500 tonnes per annum), and the costs to IVAGO of dealing with this are accounted for in the private costs.

369. In addition, some additional time is spent by households in terms of visits to the container-park. Figure 28 suggests that here has been an increase over time in the number of visits made to container-parks. It is not entirely clear the degree to which this has been motivated by the charging system itself. However, following the introduction of the DVR scheme, in July 1998, there does appear to have been an upward shift against the background of an upward trend. In 1999, one can estimate that the increase in visits over and above the background trend was around 100,000 visits, or marginally less than one visit per household.

79. These are potentially significant. A recent USEPA study suggests that the savings in terms of greenhouse gases alone amount to 2.71 tonnes of CO<sub>2</sub> equivalent (see USEPA (2003)).

**Figure 28. Change in number of visits to container-park over time in Ghent**

370. Using the same assumptions as in the case of Torelles de Llobregat (each journey to and from the site takes 40 minutes, 30% of time attributable directly to the activity, value of time foregone €-10 per hour), then including this as a cost, without any counterpart benefit, would increase the costs of the system by €1.77 – €2.22 per household. These costs – much lower than for Torelles de Llobregat – illustrate the significance of widening the scope of materials collected for recycling / composting through convenient kerbside recycling systems.

371. The net benefits depend upon the degree to which one assumes the charging scheme is responsible for the changes concerned. Attributing all the change to the charging scheme seems unrealistic and would lead to benefits far greater than in the other schemes examined even though the effect on waste prevention is barely existent in this case. Even where 25% of the effects on the change from 1997-1999 are attributed to the scheme, however, net benefits lie between €3 and €5 per household.

#### A.6.9 Summary costs and benefits

372. The potential permutations of costs and benefits are shown in Table 28 below.

**Table 28. Balance of costs and benefits of DVR scheme, Ghent**

	25% effect		50% effect		100% effect	
	Low Damage Costs	High Damage Costs	Low Damage Costs	High Damage Costs	Low Damage Costs	High Damage Costs
Private Costs	€2.87	€2.87	- €2.08	- €2.08	- €12.97	- €12.97
External Costs, Time Excluded	- €2.61	- €5.28	- €5.21	- €10.56	- €10.43	- €21.12
External Costs, Time Included	- €0.84	- €3.06	- €3.44	- €8.34	- €8.66	- €18.90
Balance of Costs and Benefits Per Household, Time Excluded	€0.26	- €2.41	- €7.29	- €12.64	- €23.40	- €34.09
Balance of Costs and Benefits Per Household, Time Included	€2.03	- €0.19	- €5.52	- €10.42	- €21.63	- €31.87

373. As with the case of Torelles de Llobregat, there are few permutations where the system imposes net social costs. These are where a) a relatively small effect is attributed to the DVR scheme, and b) where the damage costs used are low (so benefits of avoided disposal and recycling are smaller). Again as in the Torelles de Llobregat, the situation appears slightly worse where the costs of time are taken into account. However, in the case of Gent, including these has a smaller effect, and even in the worst case, the net social costs are of the order €2.00 per household.

374. If, on the other hand, the DVR scheme is attributed with a more significant proportion of the change occurring between 1997 and 1999, then benefits may be as high as around €10 per household (50% effect attributable) rising to €11-34 if all the change occurring in the period is attributed to the DVR scheme.

375. On balance, therefore, and based upon the effects of DVR schemes in similar situations elsewhere, it seems likely that the DVR charging scheme will have contributed to the generation of net social benefits. Indeed, perhaps the more important observation is that, as part of a package, the DVR scheme contributed (however significantly) to the generation of net social benefits of the order €20-30 per household.

## ANNEX 7: EXPERIENCE IN OTHER COUNTRIES

376. This annex provides some information on experience in other countries with charging schemes. The information is not comprehensive. It is intended to provide a flavour of the trends in some countries, notably New Zealand, Australia and Korea. A range of other countries outside Europe, North America and the above-mentioned countries are known to have experimented with charging schemes.<sup>80</sup>

### A.7.1 Korea

#### A.7.1.1 Introduction

377. In 1995, Korea became the first country to implement a nation wide DVR scheme for household waste. Prior to the introduction of the system, the municipal waste management system was funded through property taxes or through monthly lump-sum payments which did not vary with the quantity of waste generated. The country's rapid urbanization coupled with increased consumption linked to the country's economic growth gave rise to considerable increases in the quantity of solid waste. Most waste was destined for landfill, and the country's high population density and limited land area was giving rise to difficulties as regards siting new landfills.

378. Recycling did increase – albeit from low levels – in the early 1990s, the rate increasing from 4.6% in 1990 to 15.4% in 1994. It was against this backdrop that the Korean government introduced the Volume-based Waste Fee (VBWF) system. The system was established as a means to generate an economic incentive for waste reduction and to generate revenue to support a recycling service which is free at the point of delivery. The decision was taken to base the system on a pay-per-bag system since it was believed to be awkward to make use of rigid containers in such a densely populated country, and because the use of pre-paid sacks made revenue collection more straightforward. Each municipality is, however, free to choose the type, colour and materials of the designated sacks, taking into account specific needs. Generally, sacks used by municipalities vary in size from 2 to 100 litres. Compostable bags are used for containment of food waste.

379. The target wastes are municipal solid wastes from households, commercial sectors, small businesses and office buildings (those generating less than 300kg per day). The principles behind the system are shown in Table 29.

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80. See, for example, Sauer *et al.* (2003).

**Table 29. Underlying principles of the Volume-Based Waste Fee in Korea**

Source		Types of waste	Use of VBWF bag	Cost born by the Source	Notes
Household and small commercial sector	Urban area	Household waste	Yes	Yes	Separate collection
		Recyclable waste (paper, cans, bottles, metal, plastics)	No	No	Separate collection
		Bulky waste (furniture and electric home appliance like)	No <sup>1</sup>	Yes	Separate collection
		Construction and demolition debris	No	Yes	Separate collection
		Food waste	No	No	Separate collection
	Rural village (farming/fishing)	Agricultural waste	No	Yes	Village-level VBWF
Large commercial sector / small business		MSW type <sup>1</sup>	No	Yes	Large quantity generator more than 300kg/day

Notes:

<sup>1</sup> For bulky wastes, the waste holder must purchase a sticker from the county or city district offices. The cost of the sticker varies according to the size and type of item being discarded.

<sup>2</sup> Large quantity generators were excluded from the system, but they are encouraged to use the VBWF system if the wastes they generate are of a similar nature to the others covered by the system

Source: Korea Environmental Policy Bulletin, Issue 1, Volume 1.

380. It used to be the case that only dry recyclables were collected separately. Food wastes were discarded in VBWF bags with other residual wastes. However, more recently, to promote composting of food waste, it is now collected free of charge in designated food waste bins or bags. This scheme is now very widespread, having started in 1997 as a scheme mainly for large waste generators such as restaurants. Ever since 2005, the direct landfilling of food waste from urban areas has been banned.

#### **A.7.1.2 Cost recovery**

381. The revenue from the sales of VBWF bags is intended to support the costs of delivering waste management services. Consequently, it was always intended that the price of a VBWF bag should cover the costs of collection, transport and treatment as well as the costs of making the bag.

382. In practice, the prices for bags are gradually increasing since it was felt that a sudden increase in the cost of waste services for the householder might give rise to negative side effects. Each municipality, therefore, effectively establishes a different rate of cost recovery (the resident's share of the full cost) for citizens depending upon its financial circumstances and the costs of waste treatment which prevail locally.

383. For waste that is difficult to be contained in VBWF bags (i.e. small quantities of demolition waste, bulky wastes, other wastes from small businesses), the total treatment cost is levied on the generator.

384. As Table 29 shows, the collection for recyclables incurs no direct charge (the VBWF bags are not used). The materials collected include those outlined below in Table 30. The introduction of separate collection for food waste was given considerable impetus in 1997 when regulations requiring separate collection and recycling of food waste were introduced for restaurants and other catering facilities which

produce large quantities of food waste. Since then, the system has expanded to smaller-scale generators and households in general.<sup>81</sup>

### Materials Collected Separately for Recycling

**Table 30. Materials collected separately for recycling in Korea**

Categories	Items
<b>1. Paper</b>	- Newspaper
	- Books, notepaper, paper bags, calendars, packaging paper etc
	- Cardboard boxes (from snacks, packaging, etc.)
<b>2. Cans</b>	- Steel and aluminium food and drink cans
	- Other cans (butane gas, pesticide containers)
<b>3. Glass Bottles</b>	- Drinking water bottles, other glass bottles
<b>4. Metal</b>	- Scrap iron (engineering tools, wire, nails, ironing board, etc)
	- Nonferrous metal (nickel silver, electric wire)
<b>5. Plastics</b>	
- Extended Polystyrene	- Fruit boxes, etc
- PET (1)	- Drinks bottles (coke, soda, juice), water bottles, soy sauce bottles, oil bottles
- HDPE (2)	- Water bottles, shampoo and detergent containers, white rice wine bottles
- LDPE (4)	- Milk bottles, rice wine bottles
- PP (5)	- Boxes (beer, cola), garbage cans, dustpans, etc
- PS (6)	- Yogurt containers, etc.
<b>6. Textiles</b>	- Cotton
	- Other clothes
<b>7. Waste from farming village -</b>	- Pesticide bottles
	- Silage wrap and other films from farming
<b>8. Others</b>	- Recyclable items depend upon regional circumstances

Source: Korea Environment Policy Bulletin, Issue 1, Volume 1.

385. The expected effects of the existing VBWF system might, therefore, be as follows:

- On implementation of the system, the incentive to reduce waste generation, combined with the incentive to make more efficient use of recycling services, as well as the incentive for illegal evasion, would tend to reduce the quantity of waste disposed of using VBWF sacks;
- This would tend to reduce the revenue generated by sales of sacks;
- In order to maintain / increase the proportion of costs recovered by the sale of VBWF bags, the unit charge would have to increase. This, in turn, would be expected to generate an incentive to further reduce waste generation and further improve efficiency of use of the recycling services, as well as increasing incentives for illegal evasion;
- The costs of service provision will have been affected by the change in the route through which materials are collected (whether in VBWF sacks, in the recyclables collection, in the collection for food waste, or in the clean-up of areas where any illegally deposited waste is dumped). Depending upon how the different services are configured, then depending upon the degree to which overall waste collection is reduced, costs of the scheme may or may not increase. It should be added that the costs of the whole system are critically affected by the relative costs of

81. It should be noted that, other things being equal, the inclusion of larger waste producers on a collection round for households would be expected to improve the efficiency of the logistics considerably relative to a situation where only household food waste was collected.

residual waste treatments (e.g. landfill) and the costs of dealing with separately collected materials.

386. Consequently, it is possible that as bag sales have fallen, so the temptation to increase the unit price may have increased. However, the overall budgetary implications of such increases depend critically upon the own-price and cross-price elasticities of demand for the different service components.

387. Just as important for cost recovery, however, is the political stance of the elected bodies in the municipality of concern:

*Waste collection and treatment cost are not yet fully reflected in the price of VBWF bags, and the degree of self-reliance of local governments on their budget for waste treatment is still low. Resident's share of the total cleaning cost remains at 50 percent of the total cost, mainly due to reluctance of the local governments to push up the price of VBWF bags. Main reason being, the heads of local municipalities are elected by popular vote and are sensitive to the voting behaviour of the citizens.<sup>82</sup>*

388. This highlights a potential issue for a scheme such as this whose intention is to recover all costs through variable pricing, such as with the VBWFs. Most programmes recognize the problem of revenue instability associated with schemes which seek to recover costs entirely through variable rate charges. It should not, therefore, be seen as a flaw of charging systems that they do not recover all of the costs of waste management through variable fees alone. Rather, it is likely that a proportion of costs will have to be recovered through other means for the foreseeable future.

#### **A.7.1.3 Distribution of bags**

389. Residents purchase bags from grocery stores, convenience stores and other premises which are readily accessible to the public. Across the country, over 100,000 outlets now exist. Local government either liaises directly with the stores, or allows an intermediary (such as a cleaning organization) to arrange for the sales of the bags. A recent innovation has been the introduction of bags in supermarkets for use both as grocery bags and, subsequently, VBWF bags. This ties in with existing policy in South Korea whereby the free distribution of vinyl carrier bags is banned. Disposable vinyl bags are sold at 20-50 won per sheet. By making such bags dual purpose, the intention is to minimize the use of bags additional to those required for waste disposal.

#### **A.7.1.4 Specification of bags**

390. The VBWF bags for residual waste are made of polyethylene (PE), PE with more than 30 per cent of biodegradable resin, or PE with more than 30 per cent of calcium carbonate. Tensile strength and other specific standards are set for each bag. The bag containing calcium carbonate is primarily used for incineration treatment and biodegradable resin bag is used for food waste compost. The colour of the bag for household use should be translucent or obscure to protect personal privacy. Bags for public use (street cleaning, etc.) are light blue coloured and are not used interchangeably with other VBWF bags. The bags for food waste disposal are made transparent to allow a check by collectors for avoidance of contamination by other materials (this is relevant to the discussion of 'leakage' above – see Section A.2.1.4).

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82. Korea Environmental Policy Bulletin, Issue 1, Volume 1.

**Table 31. Composition of sacks and relevant uses in Korea**

Composition		Primary Usage	Note
PE	HDPE	Bags for general use	
	LDPE	Bags for general use	
AP+starch+LDPE (biodegradable)		Bags for food waste compost-use only	Aliphatic polyester
AP+starch+HDPE (biodegradable)		Bags for food waste compost-use only	
CaCO <sub>3</sub> +HDPE (LDPE)		Bags for incinerator-use	Contains more than 30% of Calcium Carbonate (CaCO <sub>3</sub> )

#### ***A.7.1.5 Illegal dumping***

391. The scheme imposes fines upon those who seek to evade the VBWF by illegally dumping or burning waste. Fines of up to 1 million won can be imposed upon transgressors where they are caught. Monitoring of illegal behaviour and enforcement is carried out by members of local environment groups and other NGOs. Supervision specialists are also employed for longer term monitoring.

392. Recognising the limitations of the system based upon direct regulation and enforcement, in the year 2000, a reward system for reporting unlawful activities was introduced. Under the reward system, anyone who reports unlawful activities is paid up to 80 percent of the fine charged to the person caught disposing of waste illegally. Unlawful activities can be reported through the environmental pollution report centre or on the internet. This system has reportedly contributed to expanding the social awareness on preventing the indiscriminate dumping of wastes.

393. It is generally recognized that the potential for illegal dumping to become a problem is greater in rural areas simply because of the space available for the activity to occur. There are two reasons for this. First, the opportunity is so much greater in that rural areas are characterized by large areas of land where relatively few people are present (so the activity goes unseen and potentially unreported). The second reason is that the illegal dumping itself may be more likely to cause problems in the environment precisely because of the nature of rural areas, and the (likely) greater presence of wildlife. In rural areas, also, it may be more expensive to collect dumped waste since it may be more sparsely scattered across the landscape.

394. In July 2002, a village-level VBWF was introduced. In these systems, the head of the municipality is required to install community waste collection bins for both recyclables and residual waste separately. Supervisors for waste collection are designated, and they are responsible for monitoring the system. A waste fee is then charged for the whole community, and this is later split into equal amounts across households in the village.

#### ***A.7.1.6 Removing fly-tipped waste***

395. Where waste is dumped, or fly-tipped, the potential for hot-spots to develop is real. In order to reduce the degree to which households see dumping as 'acceptable', or prevalent, it is taken to be important (amongst other things) to ensure regular removal of any fly-tipped materials. This also ensures that problems associated with poor hygiene do not develop.

396. Partly in response to the issue of illegal dumping, each city or town has been given responsibility for maintaining cleanliness of the urban environment. Through Article 7 of the 1999 Waste Management Act, the scheme allows the mayor or the head of the local or provincial government to issue notices to a landowner ordering the clean-up of waste which has been fly-tipped or burned. This is an interesting approach, and has the effect of externalising – to landowners – the costs of dealing with dumping which arises from the implementation of the VBWF scheme (or any other reason).

*A.7.1.7 Assessment of Performance*

397. The performance of the VBWF scheme can be measured in a number of ways. In the ideal situation, one assesses either:

1. the changes in performance occasioned by the introduction of the VBWF scheme against the backdrop of a constant level of service provision; or
2. the comparative performance of schemes with the VBWF scheme against those without, controlling for the level of collection service on offer.

398. It would seem that over past years, the VBWF scheme has been implemented widely, but with changes in the collection systems being made at the same time. Consequently one would ideally use a set of data in which the performance of each municipality could be assessed in the context of different collection systems and different rates of charge for VBWF sacks.

399. The following assessment is based upon national data. This national performance data reflects not only the presence of the VBWF scheme, but it also reflects improvements in the infrastructure for separate collection of materials (for example, for food waste – see above). Hence, unless stated otherwise, it cannot be taken as evidence of the success of the VBWF policy on its own.

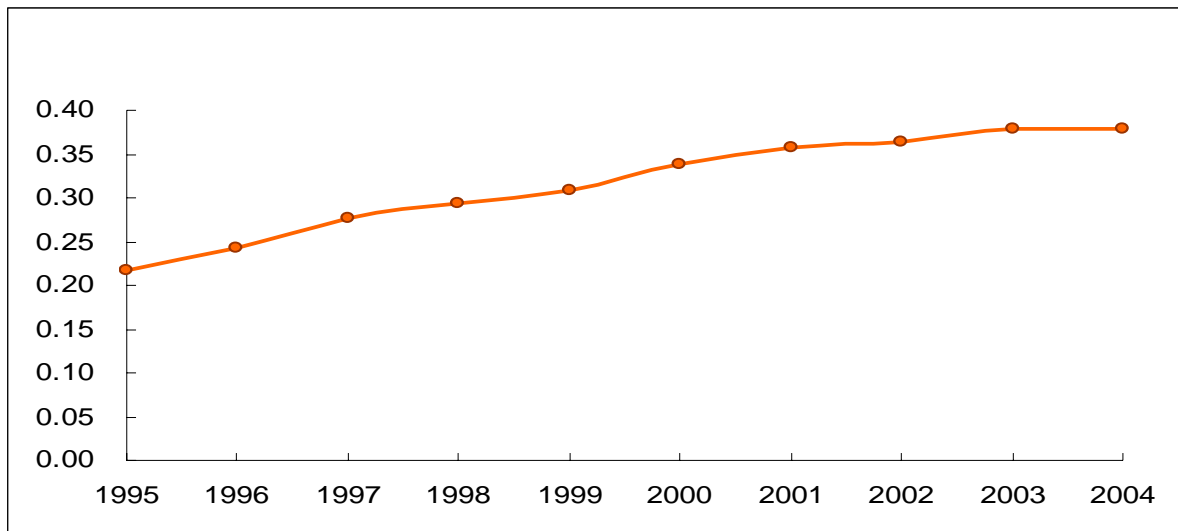
*Bag Prices and Sales*

400. First, as was made clear above, the municipalities are free to set their own tariffs for the VBWF bags. Prices have risen in specific municipalities by varying amounts in the years since the policy commenced. In some jurisdictions, the increase in price between 1995 and 2001 was as high as 170%. In others, increases have been in single figure percentages over the same period.

401. For a range of 20 cities, the price for a 20 litre bag varied from US\$0.14 to US\$0.25 (the highest was 179% of the lowest) in 1995 whilst in 2004, the variation was from US\$0.26 to US\$0.81 (the highest was 312% of the lowest). This suggests differing priorities and political perspectives on the policy at the local level. It also suggests that the potential for ‘waste tourism’ may be growing as citizens may, to an increasing extent, be able to dispose of residual waste at lower cost through using the VBWF bags of other municipalities.

402. These local increases have led to a general increase in the price for a 20 litre bag at the national level. This is shown in Figure 29.

**Figure 29. Prices for 20 litre volume-based waste fee bags, Korea**  
1995-2004



Source: Korea Environmental Policy Bulletin, Update Version of Issue 1, Volume 1, January 2006. Average fee per 20 litre bag.

403. Table 32 below shows the trend in bag sales by region over the period 1995-2001, during which, bag prices have exhibited a steady upward trend. This shows that between 1995 and 2001, the number of VBWF sacks used fell by 38%. The reduction was particularly marked in the early years of the scheme implementation, whilst there was actually an increase in 2001.

404. An important feature of the scheme is the range of bag sizes generally made available. Typically, bags of 5, 10, 20, 50 and 100 litre capacity are made available. This range enables the householder to choose the bag size which best fits their circumstances. The range of bag sizes enables householders to benefit from marginal reductions in waste volumes. If fewer sack sizes were available, there would be less incentive to reduce waste within 'size bands', especially given that householders are not charged in accordance with the frequency of set-out of their wastes.

405. In 2001, the 20 litre bag was the most popular, and there is some evidence to support the view that as the fees rise, so consumption moves towards the smaller sized bags.

#### *Waste Quantities*

406. As a result of the Volume-based Waste Fee System, daily per capita waste amount fell from 1.33kg in 1994 to 0.98kg in 2000, before rising again in more recent years. The amount of waste being landfilled or incinerated fell by 48% over the decade 1994-2004 while the collection of recyclable goods rose by staggering 175%. The recycling rate also jumped from 15.4% to 49.2%, while the landfill rate dropped from 81.1% to 43%.

407. With an increased supply of recyclable goods, such as paper, cans and plastics, the recycling-related industrial sector saw an increase in the number of recycling businesses and improved competitiveness of reprocessing companies.

Table 32. Trend in VBWF bags sales

Region	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	Changes (%, 95- 2004)
Seoul	434,816	325,634	293,670	244,478	249,352	270,881	278,980	272,467	266,477	272,233	-37.4
Busan	131,226	97,360	91,235	66,583	60,166	64,668	60,571	65,968	61,446	58,563	-55.4
Daegu	87,865	68,875	57,691	41,422	47,748	45,108	43,464	39,533	33,985	30,748	-65.0
Incheon	96,806	70,411	60,739	45,529	48,650	50,785	47,707	48,677	45,497	47,321	-51.1
Gwangju	46,222	40,096	31,686	25,328	25,055	26,206	24,155	25,793	24,291	23,530	-49.1
Daejeon	55,769	39,285	36,076	29,224	38,239	28,782	30,239	31,872	29,271	28,810	-48.3
Total	1,589,964	1,192,770	1,095,841	913,344	945,481	981,485	988,770	987,712	941,205	926,283	-41.7

Source: Korea Environmental Policy Bulletin, Update Version of Issue 1, Volume 1, January 2006.

408. Manufacturing and distribution industries also converted their production and sales procedures to curb excessive packaging and waste generation. Furthermore, notable changes have been witnessed in people's lifestyle as well. It is now common to see people swapping or purchasing second-hand goods, buying refillable goods that tend to produce less waste, and carrying reusable shopping bags, all of which demonstrate an elevated commitment of environmental preservation

**Table 33. Changes in the amount of waste generated in Korea**  
Tonnes per day

Year	Generation			Recycling	
	Quantity/day	Change (%)	Quantity/person	Quantity/Year	Rate (%)
	(tonne/day)		(kg/day/person)	(tonne/year)	
1994	58,118		1.30	8,927	15.4
1995	47,774	-17.8	1.06	11,306	23.7
1996	49,925	4.5	1.10	13,084	26.2
1997	47,895	-4.1	1.04	13,907	29.0
1998	44,583	-6.9	0.96	15,566	34.9
1999	45,614	2.3	0.97	17,394	38.1
2000	46,438	1.8	0.98	19,167	41.3
2001	48,499	4.4	1.01	20,922	43.1
2002	49,902	2.9	1.04	21,949	43.9
2003	50,736	1.6	1.05	22,938	45.2
2004	50,007	-1.4	1.03	24,588	49.2%
94 ~2004	-8,111	-14.0%	-0.27	+ 15,661	+33.8 %

Source: Korean Korea Environmental Policy Bulletin, Update Version of Issue 1, Volume 1, January 2006.

#### *Trends in illegal dumping*

409. Over the period 1995-2001, the number of cases of illegal dumping has fallen (see Table 34). It should be noted, however, that these activities are those which are known about, and by its nature, the true number could be higher. What is notable is that the first year of the scheme saw much higher levels of illegal dumping than the later years. It may be that this supports the view that some illegal dumping in the wake of charging systems' introduction relates to short-term 'protest' activity. Once the system has bedded in, the illegal dumping falls somewhat.

410. There also appears to have been a reduction in the year 2000. It could be that this relates to two issues:

1. the reward scheme for dumping. Citizens may have become less inclined to dump in the knowledge that they might be reported by any onlooker (with a financial incentive to do so); and
2. the fact that free food waste collections were becoming more prevalent. To the extent that food waste is a significant component of residual waste, the introduction of separate collections for food waste are likely to have reduced the need to fly-tip, and the quantity available to be fly-tipped.

**Table 34. Number of cases of illegal activity, Korea**

1995	1996	1997	1998	1999	2000	2001	2002	2003	2004
1,091,849	546,901	638,660	549,277	579,021	364,855	231,268	190,849	176,714	137,390

Source: Korea Environmental Policy Bulletin, Issue 1, Volume 1.

411. Other measures introduced to reduce illegal activity appear to have taken effect in recent years. It is notable, for example, that of the cases in 2004, 75,631 (55%) were incidents which resulted in fines.

#### **A.7.1.8 Summary**

412. It is quite clear that South Korea has made notable strides in ensuring a more sustainable management of household waste over the previous decade. Evidently, the provision of an increasingly comprehensive service for collecting recyclables and compostables is a pre-requisite for improved performance in this respect. However, the VBWF would appear to have ensured that not only these services are well used, but also, that there is an incentive to reduce waste generation in the first place. During this study, no specific study on how waste has been reduced over time (where has the waste gone?) was identified (which does not mean that such a study does not exist). However, it is clear that a number of supporting initiatives will have assisted in reducing waste quantities. For example, there is an initiative to reduce the generation of food waste by seeking to adjust the cultural norm of providing large amounts of food for visitors, much of which is never consumed. These would be expected to support the broad thrust of the incentive provided by the VBWF to reduce waste, and recycle more.

#### **A.7.2 Australia**

413. Much of this section is drawn from a recent report by BDA Group and EconSearch.<sup>83</sup>

414. As in many other countries, most private operators collecting commercial and industrial and buildings and demolition waste already use variable charging regimes. BDA Group and EconSearch report that the Industry Commission in Australia found that household waste disposal costs were generally recovered through a flat-rate charge. Since these charges are commonly included in general rates, many householders do not even know that they are being charged for refuse collection, treatment and disposal, let alone the magnitude of that charge. This is very similar to the current system in the United Kingdom.<sup>84</sup>

415. Variable rate charging systems for domestic waste collection are currently used by some Councils in Australia. The Government of New South Wales recently noted that a number of Councils in the Sydney area have had some success with variable pricing structures for their waste management services. They suggested that more Councils could adopt these charging regimes for waste collection by, for example, reducing annual waste management fees where residents switched to smaller garbage bins (e.g., from 240-litre bins to 120-litre or 80-litre bins). They noted however that a major challenge to implementing variable pricing structures is the increasing numbers of multi-unit dwellings in many Council areas.<sup>85</sup>

416. In 1999 Atech undertook an investigation and review of existing variable rate charging schemes to assist NSW councils and Regional Waste Boards in determining appropriate fee regimes for waste collection.<sup>86</sup> Table 35 summarises the performance of Australian schemes where quantitative information was available.

417. They found user charges had been introduced for a range of reasons, including:

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83. See BDA Group and EconSearch (2004).

84. In the UK, a host of studies have been carried out over the years asking citizens what they think they are being charged by municipalities for their waste. Whilst the actual figure is of the order £60-70 per household, median responses from citizens are typically around £250 per household.

85. See NSW Department of Environment and Conservation (2004).

86. See Atech (1999).

- To reduce domestic waste going to landfill.
- To improve the equity of domestic waste charges.
- To provide financial signals in regard to the value of protecting the environment.

418. Atech state that user charges for domestic waste collection in Australia have been successful in the majority of cases, achieving reported waste reductions of up to 50% in some cases. Since the study was undertaken, a number of other councils have adopted variable pricing regimes, largely with the introduction of new recycling services.

419. In Wollongong Council, residents can choose between three refuse bin sizes, 80, 120 or 240 litre. If a resident chooses the 80 litre bin instead of the larger 240 litre bin, they save \$150 per year. The coarse marginal pricing signal and relatively small incentive belie the reduction in waste disposal volumes that has followed. As with experiences internationally, the provision of improved recycling services, education programs, and the like that have accompanied the introduction of variable pricing regimes are likely to have made a significant contribution independently of the charging system.

**Table 35. Schemes introduced in Australia and their effects**

Council	Scheme Description	Effectiveness
North Sydney	4-bin scheme from 1993	Domestic waste collected fell 38% between 1991/92 to 1993/94.
Shellharbour	Frequency based scheme from 1996	Waste diversion from landfill disposal to recycling increased by 15%. Over a two year period 45% reduction in waste going to landfill.
Camden	3-bin scheme from 1996/97	Recycling participating increased from 40% to virtually 100%. Recycling increased by 440%.
City of Sydney	5-bin system since 1994	Four-fold increased in quantity of recyclables.
Hawkesbury	2-bin scheme since 1997	Small reduction in waste and an increase in recyclables reported.
Manly	Extra-bin scheme since 1995	Waste volumes reported to have dropped by 50%. Part of the drop is attributed to the introduction of a recycling service.
Warringah	2-bin scheme since 1997	Increase in waste and increase in recyclables. Differential in charges considered insufficient to provide and incentive for waste reduction.
Victoria	15 Victorian councils introduced variable rate pricing as part of a Kerbside Development Program.	Reduction in general waste from an annual average of 15kg/household/yr to 6-9kg /household/yr. For every additional 2kg of waste diverted to recycling there is an estimated 1kg decrease in total waste (avoided).

Source : Atech (1999).

### A.7.3 New Zealand

420. In New Zealand too, there are a growing number of Councils making use of user-pays charges. Information concerning about half of the Councils in New Zealand is given in Table 36. This comes from work undertaken by Invercargill City Council in March 2005. The term UAC stands for 'Uniform Annual Charge'.

**Table 36. Comparison of kerbside refuse collection systems used by New Zealand councils**  
March 2005

Council	System used	How funded	Price	Years in use	Comments
Ashburton District Council	User pays bags for refuse. Also provide a 45 litre recycle crate to households and businesses in the township areas.	User pays refuse Rates funded recycling	\$1.25 per bag		Refuse collection and handling is covered in the cost of the bag Bags sold at council and various shops – post shop, dairies, supermarkets, Mitre 10, garage Bags measure 370mm x 260mm x 900mm and are made of No.2 plastic Recycling is carried out on the same day as refuse collection
Auckland City Council	120 litre wheelie bins  Inner city has bags, high-rise buildings have a variety (240 l WB and up).	Targeted rate	\$129 pa (includes broad range of waste services incl. recycling, inorganic collections, haz-waste collections, education, dumping etc).	4 years	Wheelie bins are a great system, high customer satisfaction, provides a modern service Mitigates health and safety issues Feel that the wheelie bin doesn't discourage waste minimisation, average 10.5kg per bin. Reducing from 240 litre to 120 litre bin reduced waste dramatically, 35% in 2 weeks. Possibly could have reduced to a smaller bin again (80 litre?), but would have required huge public shift in mindset. Important that the overflow has somewhere to go when reducing i.e. adequate capacity in recycling system Recycling collection doesn't include paper/cardboard, picked up separately by FullCircle.
Buller District Council	Plastic bags brought from Council or Super markets	User pays	\$1.70 ea		
Central Hawkes Bay DC	35 litre recycled plastic bags, 52 p.a.	Rates funded User pays for additional bags	\$1.00 ea for additional bags	18 mths	The smaller bag was introduced alongside kerbside recycling, recycling drop-off centres, greenwaste separation & user-pays at transfer stations. The bag size was an issue at first (original paper bag 60 litres) but an intensive waste min education push for first six months saw more understanding in community and less complaints (now ongoing education). Recycling volumes increased steadily and refuse to landfill decreased by 50%
Christchurch City Council	Plastic rubbish bags, coupon system through rates. Recently reduced from 52 to 26 bags p.a.	Rates funded User pays for additional bags	\$1.00 ea. for additional bags	10 mths	Additional bags are sold at Council or from supermarkets Initial research suggested that 20% of households may choose a wheelie bin service when bag numbers were reduced Wheelie bins cost around \$280 per year from private collectors
Dunedin City Council	Plastic bags, 40 litre & 65 litre sizes, partially made of recycled plastic.	User pays, buy bags as needed.	\$1 (may rise to \$1.30)	1.5	Those who use the system pay for their own waste Private companies offering wheelie bins (up to 240 litres) is a major problem. Estimated 35% of residents use the private wheelie bins for mixed waste, including organics Have had complaints about the bags being plastic, not paper

					Animals can tear them up Would recommend including price of 52 bags in the rates, rather than rely on people to buy them
Far North District Council	No council refuse collection. Private collectors offer kerbside refuse collection	User pays	Varies i.e. \$24 for 4 lifts (240L) or \$6 per lift \$16 for 4 lifts (120L) or \$4 per lift		At least 1 private company uses a 'pay as you go' system with wheelie bins, using pre-pay tags sold through supermarkets or from the drivers. Paying a yearly lump sum is optional.
Gore District Council	Plastic bags, purchase from supermarkets and council.	User pays and partially rates funded	\$1.70 per bag	2 years	User pays is more equitable Bags break causing animal problems Estimate about 25% or more use private wheelie bins, either 240 or 120 litre.
Gisborne District Council	Council provides stickers for 1 x 5kg per week. Householders can use any suitable bag.	Rates funded, extra bags are user pays.	\$130-1.50 per additional bag	3	Recycling collection is also funded through rates Council has no control over price of additional bags, depends on the retail outlet Bag size and number provided by council (through rates) was reduced when recycling began (70 litre bin).
Hastings District Council	60 litre orange plastic bags	User pays	\$1.25	8 mths	Feel user pays is very fair and equitable Slight increase in waste volumes when bags started, which has now levelled out Caused significant rise in kerbside recycling volumes Cost of bags covers collection, contract, disposal and aftercare (aftercare costs are therefore covered by this generation) A large international waste company has moved in to offer wheelie bins, but some people are now changing back to bags Positive spin-offs for the rural community using the bags - dumping less and recycling more Initial complaints died off after 4 weeks
Horowhenua District Council	Plastic bags, 2 sizes	User pays	\$1.40 large \$0.90 small	15	No issues with public over cost as system is well established System is almost entirely self funding Cost of the bags contributes a small amount to kerbside recycling
Hutt City Council	Black plastic bags, 2 types, handle and tie top	User pays	\$1.00	13	Bags are purchased from supermarkets, or Council
Invercargill City Council	120 litre wheelie bin	Rates funded	\$82 UAC (Adjusted yearly to reflect actual tonnes disposed to	8	Tidy and robust system, minimises litter More manageable for elderly, people with disabilities Well accepted by public UAC does not reward waste minimisation or discourage thoughtless wasting

			landfill)		Some people fill up bins with greenwaste because they have extra space created by kerbside recycling
Kawerau District Council	60 litre residual bin collected weekly 60 litre weekly recycling collection 240 litre greenwaste collection	Rates funded, additional refuse bins at \$100 per year			Users contaminate greenwaste bin with other refuse, haven't been able to stop this despite imposing penalties.
Manukau City Council		Rates funded UAC			
Marlborough District Council	Blue 40 litre plastic bags, council provides 52 bags a year through a voucher system	Rates funded User pays for additional bags	\$66 UAC	Many years	Private company(s) provide 120 or 240L wheelie bins, which some residents use for convenience in addition to the 52 supplied council bags Extra bags sold from council or supermarket Bags do limit the amount people can dispose of Disposing of greenwaste can be a problem for people who can't get to the transfer station Considering a council funded greenwaste collection in the future.
Masterton District Council		User pays			
New Plymouth District Council	Plastic bags 60 litre. One per rateable household per week. Prepaid Excess/ Commercial stickers available for additional volumes and non rated properties	Targeted rate with user pays for excess refuse volumes	\$43.00 Targeted rate \$1.00 prepaid sticker	8	Collection through council contract in conjunction with kerbside recyclables collected in supermarket bags. Targeted rate allows each property within the collection area to put out one bag per week - Public Health reason. Excess / Commercial refuse from non rated properties use user pays stickers. 20% households prefer a greater service and have leased wheelie bins from several rubbish contractors. Wheelie bins are a problem as most are 240 litre although some 80 litre ones on the market. Bagged rubbish is good for managing the landfill as household refuse arrives pre packed. Cat and dog problem with kerbside bags, however we allow a tied bag to be placed at the kerb in an open rubbish tin to assist in reducing the cat and dog problem.
North Shore City Council	Orange 60 litre pre paid bags, coupons that can be attached to any garbage bag. 140 litre bins for recycling being introduced in July 05.	User pays	\$1.30 bags \$1.25 coupon UAC recycling	15	
Palmerston North City Council					
Papakura		Rates funded			

District Council		UAC			
Porirua City Council		User pays			
Queenstown Lakes District Council	Blue plastic bags, people buy from shops	User pays	\$1.40		<p>User pays is good but plastic bags are untidy in a tourist destination Dogs get into them, especially when left out for days by holiday-home owners A private contractor currently supplies a 240 litre wheelie bin service and a levy comes back to council for collection and disposal costs</p> <p>When kerbside recycling starts they will phase in 120 litre wheelie bins on a UAC Currently writing by-laws to prevent non-licensed collectors from operating and restrict all waste collection to 120 litre wheelie bin or less.</p> <p>A pay-per-tip system with bins is considered ideal, but administration and costs of this are not fully known</p>
Rodney	No council refuse collection. 8 private companies provide services in the district using plastic bags and wheelie bins.	User pays	\$1.45 per bag  Bins vary i.e. \$260 pa 240L \$190 pa 120L	15	<p>Council refers the public to private collectors to arrange a suitable service Bags are sold in shops, wheelie bins are rented to customers Council licence all collectors to ensure compliance with certain requirements i.e. container suitability, hours of operation, spillage</p> <p>Still receive complaints from people blaming the council for problems with their service Not owning transfer stations tends to create the most issues Council are still responsible for safeguarding the community and ensuring refuse is disposed of in a safe and healthy manner</p> <p>Some control still needed through bylaw/environmental health officers Disposal costs are driving some companies to start resource recovery initiatives to save money</p> <p>Council are currently reviewing how the system impacts efforts to minimise waste, acknowledge that some control is necessary</p> <p>Working more in partnership with private companies may provide a way forward</p>
Rotorua District Council		User pays			
Selwyn District Council	<p>Refuse collection – optional user pays refuse bags or optional 240 litre</p> <p>Recycling collection 60 litre crates – compulsory recycling charge.</p> <p>Proposed optional</p>	<p>UAC for refuse collection, on rates. User pays refuse bags. Separate MGB charge on rates. Separate recycling charge on rates. LGA s544</p>	<p>UAC \$18.50 each dwelling on the collection route. Refuse bags \$1.00 ea Refuse wheelie bins \$260 pa Recycling \$46.65 pa Organics not yet confirmed but likely</p>	<p>UAC, bags and MGBs since 1998. Recycling 1.5 years.</p>	<p>Collection costs are relatively expensive because of the sparse population. Urban, rural-residential and intensive farming areas are serviced. Some rural areas are not serviced. Special arrangements apply in high country villages.</p> <p>Only the UAC and the recycling collection are compulsory. The UAC is essentially an availability charge and has a number of advantages for councils considering elements of user pays.</p> <p>Providing optional MGBs at a competitive price allows the council to maintain control of the residential waste stream whilst the Council works on the introduction of waste minimisation measures. Private MGB and drum collectors are not competitive in the council's collection area but they provide a useful service outside of the council's collection area. The Council will encourage refuse MGB subscribers to convert to organic MGBs plus the</p>

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	garden and food organics collection 240 litre MGBs	Allocation of Costs	approx \$200 pa		bag collection option, once the council's in-vessel composting plant is installed. (A contract has been let and the plant should be operational late 2005)
Southland District Council	240 litre wheelie bins collected weekly	Rates funded	\$155 urban (compulsory) \$234 rural (optional)	7	Well received by public now, after initial resistance, convenient Holiday home owners have to pay full cost for minimal use of service Bin replacements need a police report, can be inconvenient People can throw out indiscriminately Large bins don't encourage waste minimisation
Stewart Island	60 litre recycle crate, 20 litre scrap bucket and 60 litre degradable plastic bags (52 pa). Weekly collection.	Rates funded	\$230 pa \$2ea for additional bags	1	Gives people opportunity to recycle most waste Good diversion rate, about 32% so far 3 containers can be inconvenient i.e. 3 trips to roadside Some resistance to new system and cost People seem to use refuse bags most
Tararua District Council	Customers buy plastic bags, we sell labels	Users pays, rates top up	\$1.50 per bag \$0.75 per two supermarket bags	8	Initial concern, now works well.
Tasman District Council		User pays			
Taupo District Council	Council bags Private operators offer Bags, Wheelie bins	User pays	Council Bags \$1, two half bags 50c Private, various prices	3	As recycling free (rates funded) has seen an increase from 35 to 90% participation at Kerbside Private operators have bulk of refuse collection market
Timaru District Council	Predominantly 240 litre wheelie bins	Rates funded	UAC	15	Currently reviewing system and considering 3 bins system for organics, recycling, rubbish
Waikato District Council (except Raglan)	Max 2 x 60 litre bags per week. Cost includes kerbside recycling for around 75% of properties in the collection area.	Targeted rate on properties serviced	\$92	>10	No significant problems with the service. 93% of users are satisfied/very satisfied with the rubbish collection Approx 70% of users are satisfied/very satisfied with the kerbside recycling (Paper, kraft, glass only) We keep getting requests to extend the kerbside recycling collection even further into the rural areas, mainly to service new lifestyle block developments.
Waikato District Council (Raglan only)	Prepaid bags and kerbside recycling	User pays refuse Targeted rate for kerbside recycling	\$1.40 per 65 litre bag \$0.80 per 35 litre bag \$38 per property plus some general	3-4	Need good kerbside recycling where prepaid bags are used. 73% of users are satisfied/very satisfied with the Raglan prepaid bag rubbish collection 84% of users are satisfied/very satisfied with the Raglan kerbside recycling (incl. plastics and steel cans)

			rate funding		
Waimakariri District Council	Council branded plastic rubbish bags (65 litre capacity), bought from Council or supermarkets / shops.	User pays for bags, some funding from fixed rate of \$76	\$1.00 ea. for bags, budgeted to rise to \$1.10 ea next year	6	When kerbside recycling began in 2000/01, Council stopped delivery of bags and removed the bag cost from the fixed rate. Bags are sold at Council or from supermarkets Private companies offering 240 litres wheelie bins or 44 gallon drums is a major problem Some initial resistance to cost, but general acceptance of 'waster pays' at current bag price Price rise last year saw abrupt increase in kerbside recycling weights & corresponding reduction in refuse weights
Waitakere City Council		User pays			
Waitomo District Council					
Wanganui District Council	No council refuse collection. Private companies use a range of bags and bins	User pays	\$1.50 per bag \$220 p/a for a 240L bin	7	The public pay actual, non-subsidised costs for disposal Reduced waste volumes immediately People now throw away indiscriminately Council cannot exert influence on waste services, restrict volumes or apply levies
Wellington City Council	Plastic bags, bought from council or supermarkets / shops	User pays	\$1.85 ea		
Westland DC	Plastic bag, 26 free pa, buy any more needed	Where collection reaches, \$45 rates item and remainder user pays (50% cost recovery)	\$1.00 per bag	3	Only in Hokitika, all other centres take waste to local facilities, and pay no refuse rate Bag sales thru supermarkets and shops Also have private services, drum hire etc, which divert perhaps 20% of waste past council collection direct to landfill, with no incentive to reduce waste
Whangarei District Council	Council refuse collection, maximum 15kg per household per week.	Rates funded	\$38 UAC – collection \$40 UAC – facilities		Council are considering a user pays system using stickers on bags @ \$1.50 per sticker Some rural properties are not serviced, and they are not charged the \$38 UAC - collection All properties are currently charged \$40 UAC – facilities If user pays is introduced, the UAC may go to \$100 for both collection and facilities as kerbside recycling was introduced in February 2005 Council operated landfill in Whangarei is scheduled for closure in June 2005, then all residual waste will be transported to Redvale landfill via a new Resource Recovery Park and rural transfer stations

## **ANNEX 8: STUDIES REPORTING NEGATIVELY ON WASTE CHARGING**

421. Case studies on DVR schemes are not universally favourable to the approach. The key issues raised by researchers regarding the negative effects of charging have tended to centre upon illegal dumping, and other forms of evasion. This chapter highlights some studies - there is no claim to have been exhaustive in this regard - which have raised this as an issue of concern. Clearly, the study of Fullerton and Kinneman, discussed in Annex A.1.1, also falls into this category but it is not discussed further.

### **A.8.1 Denmark**

422. Approximately 20 Danish municipalities (of 275 municipalities) have weight-based schemes for domestic waste from households, smaller companies and institutions. Tinglev municipality started the first such scheme in 1991 and during the 1990s, other municipalities followed.

423. Two studies of significance have been carried out by the Danish EPA that are relevant to our subject. These have sought to shed light upon the impact of weight-based charging systems in Denmark. All the municipalities that have introduced a weight-based collection scheme are small or medium-sized, rural municipalities with few multi-storey buildings.

#### ***A.8.1.1 First Study***

424. The first study looked at 5 municipalities that had introduced weight-based collection schemes and compared these to 5 municipalities without weight-based schemes.<sup>87</sup> Two different approaches, one based upon comparative data analysis and the other based upon a questionnaire, were used.

425. The comparative analysis looked at five local authority areas with weight-based waste collection schemes, two areas with volume-based schemes and one area where households are granted a reduction in fees if they do their own home composting. A local authority area with no fee-differentiated waste collection scheme was chosen as a reference area for each of the eight areas. The questionnaire study was conducted in the same five local authority areas with weight-based waste collection schemes and in three reference areas.

426. Both approaches show that the amount of residual waste is reduced, and that the amount of paper collected in the five local authority areas with weight-based waste collection schemes is higher than in the reference areas. Nevertheless, a number of reservations should be made regarding the results.

427. For instance, it was not possible to locate reference local authority areas completely identical to the areas with fee-differentiated waste collection systems. Furthermore, direct comparisons may not account sufficiently for differences in collection schemes for recyclable materials, as well as collection frequencies, and differences in communication and information efforts in local authority areas. For example, amongst the municipalities that have introduced weight-based schemes, whilst some of the municipalities only collect domestic household refuse, others collect organic waste separately from residual waste. Municipalities also

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87. See Danish Environmental Protection Agency (2000).

collect dry recyclable fractions but usually only the smaller waste items (bulky waste is collected separately or delivered at municipal recycling stations).

### *Key Results*

428. The annual amount of domestic waste collected in the two local authority areas with volume-based waste collection schemes averaged 71 kg less per household than in the two reference areas. The capture rate for both paper and glass was more or less the same in the two local authority areas with volume-based waste collection schemes, whilst it was quite different in the two reference areas.

429. In local authority areas with weight-based schemes, the amount of domestic waste collected annually from each household averaged 359 kg less than in the reference areas. The difference drops to 279 kg per household a year when allowance is made for there being a higher level of home composting in local authority areas with weight-based schemes than in reference areas.

430. Local authority areas with weight-based schemes have a higher capture rate for paper and cardboard than the reference areas. The capture rate for glass was roughly the same in the two groups of local authority areas.

431. In the local authority area where households are granted a fee reduction for home composting, the amount of waste collected is not lower than in the reference area, which even boasts a higher collection efficiency rate for both paper and glass.

432. Table 37 shows the collected amounts of residual waste, paper and glass as well as the collection efficiency rate for paper and glass. On account of the different results from the reference local authority areas and the local authority areas with volume-based schemes, the average calculations of these two local authority areas have been supplemented with calculations for each of the two reference areas.

**Table 37. Collected amount of waste and collection efficiency rates for paper and glass**  
Calculated in kg per household in 1999

Local authority area	Residual waste	Paper and cardboard	Glass	Total	Capture Rate (%)	
					Paper and cardboard	Glass
Areas with weight-based collection schemes	325	108	38	471	71	87
Reference areas	729	67	34	830	41	77
Areas with volume-based collection schemes	552	104	40	696	61	89
Reference areas	660	76	30	766	44	67
Areas granting a reduction for home composting	573	63	28	664	46	63
Reference areas	533	86	38	657	64	86

*The capture rates have been calculated on the basis of potentials that are individual for the local authority areas in respect of paper, while the potential is the same for all areas in respect of glass.*

433. The questionnaires reveal that 59% of households in local authority areas with weight-based collection schemes say that they home compost virtually all fruit and vegetable remnants. The corresponding percentage in the reference areas is 21%. The total response rate of the questionnaire was 41%.

### *Difference in waste quantities collected*

434. The DEPA-project did not reveal any differences in the consumption habits of the citizens of municipalities with and without weight-based schemes, and it was assumed that the same amount of waste is

generated on average by households in the different municipalities. The difference in the waste amounts was assumed to be explicable only through reference to things *other than* different consumption habits.

435. The following reasons were offered for the difference in the registered waste amount:

- Waste may be delivered at recycling stations;
- Composting in private gardens may be higher than estimated in the study;
- Waste may be burned in private fireplaces/stoves or oil containers; and/or
- Waste may be dumped at lay-bys or parking lots.

436. The project did not reveal the amount of waste delivered at recycling stations and how well the waste received at the station was sorted. A higher amount of waste than assumed in the study may therefore have been recycled. This observation is important in the context of the second study (see below), which paid more attention to what happened at recycling stations.

437. Waste composting in private gardens is not included in the municipal waste statistics. The amount of waste that is composted in private gardens is therefore subject to a high level of uncertainty and may be higher than stated in the weight-based scheme.

438. The general advantages/disadvantages of weight-based waste collection schemes in Denmark are illustrated in Table 38.

**Table 38. Advantages and disadvantages of weight-based waste collection**

Advantages	Disadvantages
Higher degree of recycling of especially paper and cardboard	Garbage thrown in parking lots etc.
Higher degree of home composting	Garbage burned at the households
Economic benefits for sorting, recycling	No solidarity to e.g. families with babies that have relatively high amounts of waste
	Heavy administration

Source: Danish EPA

### *Advantages*

- According to the DEPA-project, the amounts of paper and cardboard brought for recycling are significantly higher in municipalities with weight-based waste collection schemes. The waste collection efficiency for paper and cardboard is 71% and 41% for municipalities with and without weight-based waste collection schemes, respectively.
- The waste collection efficiency for glass is only slightly higher in municipalities with weight-based waste collection schemes, or 87% compared to 77% in municipalities without weight-based schemes.
- The extent of composting in private gardens is also higher in municipalities with weight-based schemes. According to a questionnaire used in the DEPA-project, 59 % of the households with a weight-based scheme practice home composting compared to 21 % of the households with a traditional scheme.
- The DEPA-project showed that the weight-based waste collection scheme is cheaper, even with more than 4 persons in the household, although most of the municipalities have higher administration expenses.
- The scheme puts the "polluter-pays" principle into practice, since economic benefits are provided to those who sort and bring waste to recycling.

*Disadvantages*

- The weight-based waste collection system has the disadvantage that more citizens try to avoid paying the variable fees by dumping waste at lay-bys, parking lots or in their neighbour's container. Municipalities with weight-based waste collection schemes also report problems with citizens burning the household waste in oil containers or fireplaces.
- The Highway Authorities questioned in the study reported that there were greater waste amounts dumped illegally at lay-bys in those municipalities that had introduced weight-based waste collection schemes compared to those who had not. This was especially a problem when the scheme was first introduced, and in some of the municipalities, the dumping of waste at lay-bys has fallen back to the initial level.
- The collection scheme has certain consequences which may be considered negative from a social perspective. Families with babies may have a relatively large amount of waste (such as diapers, organic waste etc.). However, it is possible to address this through promotion of re-usable alternatives.
- The collection scheme is heavy in administration and may therefore have higher costs compared to a traditional collection scheme.

*User behaviour*

439. The DEPA-project shows that living in a municipality with a weight-based collection system has positive effects on the users' behaviour regarding sorting and recycling. However, according to the study, only part of the change in user-behaviour could be explained by these two changes.

440. According to the study, the following factors have more significance:

- The citizens' sense of duty of recycling waste;
- The difficulties experienced with recycling; and
- The owning of a composting container for private use.

441. The study argues that if these three factors are influenced positively, they will exert a greater effect on the recycling rate than a weight-based waste collection scheme alone.

442. No mention appears to have been made of influence on consumption patterns. However, it seems reasonable to suggest that introducing weight-based waste collection scheme can motivate citizens towards the above mentioned factors. The weight-based scheme may, for example, motivate citizens to obtain a composting container, or use it more intensively than would otherwise be the case. Citizens may also regard the initiative as a strong signal from the authorities that they should focus their efforts on recycling waste, or choosing goods which are less heavily packaged.

*A.8.1.2 Second study*

443. The above study led to further questions being asked concerning the effects of weight-based schemes in Denmark. The second report incorporated information from three sub-studies carried out in the municipalities of Tinglev and Nørre Rangstrup. The aim was basically to shed more light upon the issue of the fate of waste which the above study suggested appeared to 'disappear' in the case of weight-based schemes.

444. Table 39 shows key observations regarding composition of residual waste from the municipalities of Tinglev (weight-based) and Nørre Rangstrup (not weight-based). The analysis shows that the recorded amount of each category differs considerably.

445. Table 40 shows the amounts of animal food waste, nappies, ashes/cat litter/street litter, etc. as well as other types of waste (up-scaled in kg per household per year). All these four categories are collected as refuse in both municipalities. In these categories, the waste collected in Nørre Rangstrup is almost double (97% greater) that collected in Tinglev.

**Table 39. Composition of residual waste**

Category	kg per household per week			% difference in Nørre Rangstrup relative to Tinglev
	Tinglev	Nørre Rangstrup	Difference	
Animal food waste	0.304	0.413	0.109	36%
Vegetable food waste	2.009	2.602	0.593	30%
Flower and garden waste	0.111	0.204	0.093	84%
Nappies	0.351	0.710	0.359	102%
Newspapers, magazines and advertising material	0.116	0.470	0.354	305%
Cardboard	0.053	0.113	0.060	113%
Other types of paper material	0.157	0.227	0.070	45%
Metal tins	0.106	0.147	0.041	39%
Bottles and household glass	0.137	0.338	0.201	147%
Ashes, cat litter, street litter, etc.	0.158	0.911	0.753	477%
Other types of waste	2.196	3.884	1.688	77%
Total	5.698	10.019	4.321	76%

Source: Danish EPA.

**Table 40. Study of Categories Collected as Refuse in Tinglev and Nørre Rangstrup**

Category	Tinglev	Norre Rangstrup
Animal food waste	15.8 kg	21.5 kg
Nappies	18.3 kg	36.9 kg
Ashes, cat litter, street litter, etc.	8.2 kg	47.4 kg
Other types of waste	114.2 kg	202.0 kg
Total	156.5 kg	307.7 kg

Source : Danish EPA.

446. The study also analysed waste found in civic amenity site containers labelled "combustible waste". This, of course, is something of a Danish peculiarity (shared with Japan) since one of the policy objectives in Denmark is to ensure that only non-combustible waste is sent to landfill. As can be seen from Table 41, there is a considerable difference between the amount of refuse and garden waste recorded for both municipalities (60% and 10%). The total amount of waste in the containers of the two municipalities, however, is practically identical (1,465 kg and 1,420 kg). More than half (60%) the content in Tinglev was recorded as refuse. In Nørre Rangstrup, the refuse only amounted to 10%.

**Table 41. Refuse and garden waste found in containers labelled "Combustible waste"**

Category	Amount in kg	
	Tinglev	Nørre Rangstrup
Animal food waste	5.70	0
Packaging	152.00	14.30
Nappies	20.50	0
Newspapers, magazines and advertising material	88.60	9.10
Cardboard	34.10	14.30
Other types of paper materials	218.90	26.10
Clothes and shoes	187.50	32.05
Ashes	5.80	2.65
Other waste/refuse	127.05	22.85
Toys	3.55	18.50
Home nursing	7.60	
Total refuse	851.30	139.85
Garden waste	23.90	4.00
Total	875.20	143.85
Total waste found in containers labelled "combustible waste"	1,465 kg	1,420 kg
Percentage classified as refuse and garden waste (combustible waste)	60%	10%
Combustible waste	589.8 kg ~ 40%	1,276.15 kg ~ 90%

Source: Danish EPA.

447. Lastly, the study sought to understand the amount of waste collected at lay-bys and service areas. The recordings of waste collected at lay-bys and service areas in the four counties (Sønderjyllands Amt, Fyns Amt, Ringkøbing Amt and Viborg Amt) show that proportionally more refuse is collected from lay-bys and service areas in municipalities with weight-based collection schemes than from lay-bys and service areas in the remaining municipalities. The same conclusions cannot be made from the recordings from the county of Vejle. However, the study argues that the findings from Vejle Amt do not exclude the possibility that citizens from municipalities with weight-based collection schemes tend to leave more waste at lay-bys and service areas than do citizens from municipalities that do not have such a collection system.

#### **A.8.1.3 Overall assessment**

448. Table 42 lists under various headings the amount of waste recorded in 2000 (up-scaled for one year). For the municipality of Tinglev, the difference in vegetable food waste and garden waste has been added (up-scaled for one year). It is presumed that equal amounts of these two categories are being produced in the two municipalities, but that the difference in vegetable food waste and garden waste constitutes an additional amount which is being home composted in Tinglev apart from the amount that is supposed being home composted in the two municipalities.

**Table 42. Amount of waste recorded per household**

Category	Tinglev	Norre Rangstrup
Remaining waste (recorded by the waste analysis in 2001)	318 kg	532 kg
Paper and cardboard (2000)	106 kg	105 kg
Bottles and household glass (2000)	34 kg	32 kg
Remaining waste + paper and glass	458 kg	669 kg
Difference in amount of vegetable food waste and garden waste (0.593 kg + 0.093 kg) x 52 weeks	36 kg	-
Total refuse	494 kg	669 kg
Refuse in civic amenity container labelled "combustible" (up-scaled for one year)	74 kg	17 kg

449. Collected "residual waste" per household for the entire country averaged 587 kg in 1998 and 588 kg in 1999.<sup>88</sup> After including the additional amount which it is assumed is being home composted in Tinglev, a difference in the amount of refuse in the two municipalities can be noted (see Table 42).

450. The difference in total waste between Tinglev and Nørre Rangstrup amounts to 117 kg per household per year. The study argues:

*Since the findings of the questionnaire survey (published in the Environmental Project No. 576, 2000) do not show any difference in consumer habits for municipalities with and without weight-based collection schemes, it must be assumed that on average the same amount of waste is being produced in both municipalities.*

451. This is clearly a contestable assumption and depends on a very wide range of variables. However, the study argues that the difference in the amount of waste being collected (including home composting) in the two types of municipalities might be due to the fact that the households in municipalities with weight-based collection schemes dispose of their waste in an alternative way. This could include bringing categories other than paper, cardboard and glass to civic amenity sites; incineration in stoves/furnaces and disposal of waste at lay-bys, service areas, etc.

452. The study shows that when analysing waste delivered to civic amenity containers labelled "combustible waste", the amount of refuse was significantly higher in Tinglev than in Nørre Rangstrup. Arguably, though, this is completely unimportant when the materials found in combustible waste which 'should not be there' are precisely the same materials as are deposited in refuse sacks (for doorstep collection) in Nørre Rangstrup.

453. The study notes that when grossed up for one year, the difference in the amount of refuse found in these containers amounted to 57 kg per household per year. In addition, the analysis of waste left at lay-bys and service areas shows that the volume of refuse is higher in Tinglev than in Nørre Rangstrup.

454. The study also suggests that the work did not confirm the difference in home composting that was indicated by an earlier study.

*'The findings of the earlier questionnaire survey indicated a difference of approx. 80 kg per household per year on average. However, the waste analysis carried out in 2001 recorded only a difference in the amount of vegetable food waste of only approx. 30 kg per household (up-scaled for one year).'*

455. The suggestion is that the difference in the quantity of material home composted is calculable from the difference in the composition of collected refuse. This is unlikely to be the case. Not only will the quantities dealt with vary with average garden size (and the quantity of garden waste in residual waste at the outset was not known), but the interaction with home composting occurs not only through the doorstep collections but also through the system of bring sites / container-park s operated. The studies effectively assume that there is no such interaction.<sup>89</sup> Finally, it is not clear to what extent seasonality of the analysis might play a role in explaining these differences.

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88. Bulletin from the Danish Environmental Protection Agency No. 3, 2000 Statistics on Waste 1998 (83% of the recorded amount of refuse distributed on 2,406,968 households); Bulletin from the Danish Environmental Protection Agency No.17, 2001; Statistics on Waste 1999 (85% of the recorded amount of refuse distributed on 2,406,968 households).

89. Work being undertaken in the UK suggests that home composting diverts material equally from the doorstep collection system and from the container-park systems (personal communication, Julian Parfitt, principal analyst, WRAP).

**A.8.1.4 Comment**

456. Taken together, these studies probably raise as many questions as they answer. The first study presented a picture of weight-based charging schemes which appeared to show some benefits from charging, but also some disadvantages. The second is more equivocal about benefits. There are, however, some interesting observations to be made.

457. Firstly, one has to ask whether the approach – a comparison of two authorities – is really an adequate one from which to draw general conclusions. Secondly, the overall analysis of waste collection (see Table 42) suggests that the separate collection infrastructure is not well-developed in either community. Only paper and card, and glass appear to be collected separately, though Denmark also has a system of deposit refunds for some packaging containers. Thirdly, the attempt in Denmark to have households differentiate between materials which are ‘combustible but not for recycling’, and refuse, is one which seems likely to generate problems since who is to differentiate what should happen to mixed waste, and if the waste is not mixed, why is it ‘combustible’ rather than ‘recyclable’? This issue is all the more problematic where citizens are taking to a container-park material which would otherwise be placed in general refuse (because of the pricing issue).

458. It might reasonably be asked, therefore, whether the issues being highlighted in the study are not ones which illustrate the shortcomings of the approach to waste collection in these areas rather than highlighting genuine problems with weight-based charging.

459. It is interesting to note that the first study suggested that, on the basis of results of a questionnaire study, that although living in a local authority area with a weight-based waste collection scheme has a positive influence on household behaviour, this explains only a minor share of the variation in behaviour (no more than 14%). More important issues, the study suggested, were:

1. citizens’ sense of duty regarding recycling
2. the troubles experienced with recycling and
3. whether households use a home composting bin or a compost pile.

460. Somewhat tellingly, and confirming the above point that the weight-based schemes examined appear to be supported by relatively low levels of provision of convenient source separation services, the study notes:

*If each of these three factors could be positively affected, they would all have a greater impact on recycling (i.e. more waste would be sorted for recycling purposes and the level of home composting would rise) than the actual introduction of a weight-based waste collection scheme.*

461. In other words, there is plenty of room for improvement in the existing collection schemes, leading one to suggest that ‘evasive behaviour’ could at least be reduced by improving the system for separate collection (thereby allowing households to reduce exposure to the charge through legal rather than illegal means).

462. Lastly, one has to question the assumption that consumer behaviour is the same across all households in, and outside, weight-based systems. If these systems really have such a profound impact on people’s behaviour ‘at the end of pipe’ (including the suggested evasion), it would be strange if there was not at least some impact ‘at the front end’. The premise that those in, and those outside the schemes would produce exactly the same quantity of waste is a) unlikely (based upon experience across municipalities in any given country); b) difficult to substantiate; and c) in direct contradiction to the overwhelming majority of the evidence. To the extent that this premise guides the otherwise laudable attempt to discover the fate of waste generated, it is likely to overstate the extent of ‘evasive behaviour’ and understate the potential for genuine waste reduction. The latter seems a possibility which the premise appears to deny.

### A.8.2 Netherlands

463. Proietti cites a study conducted for the VROM by KPMG in 1995-1996.<sup>90</sup> This reported a 12 to 30% reduction in household waste owing to DIFTAR schemes, including:

- 6 to 8% due to sorting
- 3 to 10% due to unintended effects
- 3 to 12% due to prevention (calculated).

464. Following this, a study was undertaken for VROM by KPMG in 2001.<sup>91</sup> The principal objectives of the study were to understand the fate of the materials diverted from the residual waste stream, in particular, to understand the degree to which the reduction in refuse collected was due to a) 'positive' changes (in respect of genuine waste reduction) and b) 'negative' changes (in respect of evasive activities / illegal disposal).

465. Questionnaires were used to develop an understanding of households' behaviour, though the study team recognized that such questionnaires were unlikely to be reliable (since people would not voluntarily declare themselves to be acting illegally). Generally, it was concluded that both types of behavioural change –positive and negative – would occur, but it was impossible to generalize about the relative proportions of waste reduction which occurred through 'legal' and 'illegal' routes. Not only were there huge differences between different towns (and the difference between rural and urban municipalities was a feature), but it was also clear that systems functioned best where thorough provision was made for convenient source separation.<sup>92</sup> There remain, therefore, some questions concerning the fate of the 'disappearing waste'.

466. 3 types of each of 4 different 'DIFTAR' systems were examined, the 4 types being:

1. Volume based;
2. Volume and frequency based;
3. Bag based; and
4. Weight based.

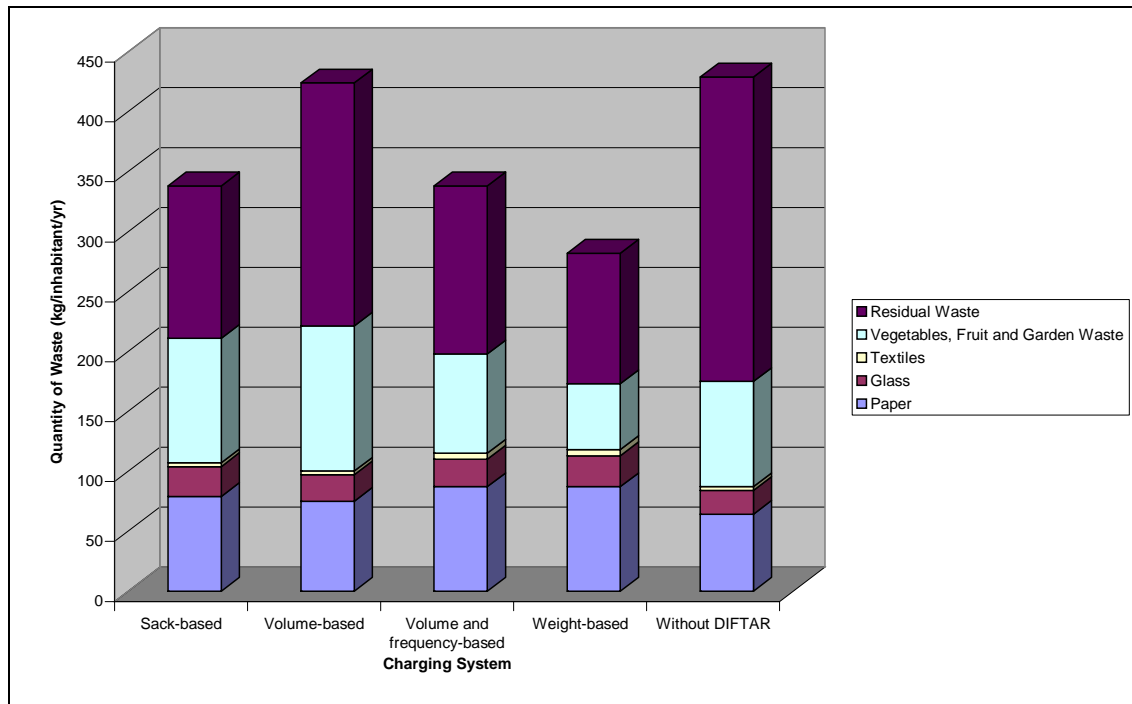
467. Comparative results across the system types were reported in an AOO publication and are shown in Figure 30.

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90. Zelle and van der Zwaan (1997).

91. KPMG Bureau voor Economische Argumentatie (2001).

92. Personal communication with S. van Weele, KPMG Netherlands

**Figure 30. Quantities of separated waste and refuse by charge system type**

Source: AOO (2001).

468. As with many other studies of charging schemes, this study led to questions being asked about where the ‘missing waste’ had gone. The quantities of waste per inhabitant observed in the weight-based schemes were so significantly different from the ‘without DIFTAR’ cases that the authors of the study (in private communications) believe that this cannot be accounted for by legal activity alone.

469. This mirrors a general pre-occupation – and it is an understandable one – with seeking to explaining the ‘disappearing waste’. Many studies treat this issue as if *municipal* waste is ‘conserved’ at the *household* level. It may be that the different types of schemes act to reduce the amount of commercial waste previously collected in the municipal stream. Municipalities frequently have a problem with commercial waste flowing into the municipal stream, especially where there is no charge applied to the collection of municipal waste. Charges may have the effect of choking off some of this flow of material.

### A.8.3 Ireland

470. Experience with charging schemes in Ireland is developing rapidly. Charging schemes have been mandatory in Ireland since the beginning of 2005. This situation has developed quite quickly following a transition from publicly operated collection services to a fully privatised system. The majority of local authorities allow private operators to make contracts with individual householders and the local authority has no direct role. In many areas, therefore, there is competition between private collectors. Private companies directly set the charge with the householder, and the local authority does not have any direct role.

471. Eunomia carried out a brief study of Fingal County in 2003.<sup>93</sup> The scheme began in 2002. Fingal County Council was one of the last local authorities to introduce a waste charge. The Council was under pressure financially and politically to introduce it. The introduction of charging took place against the

93. See Eunomia (2003).

backdrop of the attempts of national political parties to win General Elections. One party offered an abolition of domestic rates in 1977 and won a landslide victory. The rates were decimated and substituted by rate support from Government. As the costs of waste management in Ireland have escalated, so the need to generate additional revenue to support the service has arisen. Part – though not all- of the increased costs of waste management related to increased landfill gate fees, sometimes used by municipalities to support their service.

472. The Eunomia case study highlighted two important issues at the time of its completion:

- That since, at the time, local authorities had to pick up waste irrespective of whether or not applicable charges had been paid, there was an incentive for households to ignore the charges (they would still receive the service for free); and
- That this problem was probably exacerbated by the fact that the service itself did not provide sufficient opportunity to reduce exposure to the charge. Prior to the scheme's introduction, a green bin for dry recyclables had been introduced, over a period of two years, to approximately 50% of households. There were 90 bring banks throughout the county (population 200,000). The charge, because it operates for the black residual bin and not the green bin, has resulted in greater usage of green bins by those who have them. Many households still had only bins for refuse, and so were dependent upon bring schemes if they wished to carry out any recycling.

473. The reported noted:

*This scheme is of some interest precisely because it illustrates that being able to charge for waste is not, in and of itself, sufficient for local authorities to be able to implement DVR schemes successfully. Local authorities have to have powers which enable them to by-pass materials which are not paid for, or in incorrect containers.*

*The other important lesson which potentially emerges from this scheme is that it may be counter-productive to make use of such instruments for pure cost-recovery purposes (that is, without implementing quality separate collection schemes, and / or schemes with appropriate advice for home composting and waste minimisation). Following this approach tends to incur greater resentment on the part of citizens as it is difficult to reduce their liability for charges other than through less desirable, evasive behaviour.<sup>94</sup>*

474. More recently, an article by Martin has raised further questions concerning the application of charging systems in Ireland. Martin makes a number of important points concerning the context for the introduction of charging schemes in Ireland. As he puts it, 'Ireland faced a unique set of handicaps'.<sup>95</sup>

475. He makes the following points:

- The rapidity of the introduction of charging in Ireland combined with the high costs of disposal (attributed by Martin to a 'failure to make realistic disposal plans') and the desire to recover escalating costs led to the charges being introduced at relatively high levels. This was perceived as an unjust new tax, and gave rise to considerable rebellion (perhaps also because the schemes were being rolled out across Ireland, so there was some commonality of experience of resentment across the country).
- This was exacerbated by the absence of any local taxes (which had been abolished). Councils could not introduce charges against the backdrop of a promise to reduce local taxes;

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94. See Eunomia (2003).

95. See Martin (2005).

- The prevailing legislation allows households to opt out of the collection service (this is partly linked to the absence of any flat rate component to the costs of the service). This was a political decision which, Martin argues '*snatched defeat from the jaws of victory*'. This issue is exacerbated by the privatisation of services since councils where the service has been fully privatised do not know who has opted in, and who has opted out, of the many competing collection systems;
- The schemes do not systematically allow for social adjustments, and this has given rise to a sense of social injustice (leading to the jailing of a member of parliament in Dublin).
- Many rural households have no service at all yet they have to deal with their waste;
- Enforcement has been historically weak, though it is now improving. Even so, the fact that crossing the border with Northern Ireland takes one to a country where landfill gate fees are sometimes one tenth the level in Ireland generates enormous incentives for illicit cross-border activities.

476. Martin presents a poor backdrop against which to introduce charging schemes. He uses this to suggest that illegal disposal and a thriving black economy in waste are both prevalent. Quite apart from the lessons concerning enforcement, a key issue appears to be the degree to which collection systems now function autonomously without any relationship to municipalities. This seems to lead to a loss of control on the development of household behaviour.

477. One feature of the approach to charging which can help in this regard is the overall tariff structure. At least in countries where enforcement is good, the use of a combined flat- and variable-rate charging structure enables municipalities to offer a service where the marginal cost is not especially high (as compared to systems which function with no support from revenues derived from the flat rate charging element).

478. Where enforcement is poor, and where the market for services is very competitive, service providers will seek to reduce costs to householders. If disposal is cheap, the lowest cost service is likely to remain one based around the collection of refuse for disposal. This raises questions concerning the potential of charging systems to deliver anything other than low quality collection services where disposal is cheap and where the market for the provision of waste collection services has been completely opened to the market. Evidently, in the Irish case, this may intensify the search for means to pay low disposal costs by smuggling waste across the border into Northern Ireland.

## ANNEX 9: INTER-RELATIONSHIPS BETWEEN THE MUNICIPAL CHARGING SCHEMES AND OTHER POLICY INSTRUMENTS USED IN HOUSEHOLD WASTE MANAGEMENT

### A.9.1 Introduction

479. A range of policy instruments have been used in the area of household waste management. This raises questions concerning the appropriateness of the use of other instruments where charging systems are deployed and concerning the potential for complementarity of instruments to achieve specific objectives.

480. Several studies have looked at the question of what might be an optimal policy for the management of municipal waste.<sup>96</sup> Generally, the most favoured approach of most theorists is one or other combination of Advanced Disposal Fee (ADF), a charge on householders for disposal, and a subsidy for recycling or appropriate disposal. Palmer and Walls also consider an upstream combination tax / subsidy, where effectively, the ADF is replaced by a tax on materials use and the subsidy is paid to collectors of recyclables.

481. However, most commentators also recognise that the ‘deposit-refund’ type schemes may have their limitations. For example, the setting of taxes and refunds at appropriate levels for the various products is not straightforward. Furthermore, such a scheme for food waste and garden waste – which in EU Member States constitute, typically, 35-40% of the waste stream (the balance of food and garden waste varies depending upon the collection systems used and the income status of the country) – is, for all intents and purposes, redundant.

482. Equally, it is recognised that charging systems have limitations if they are to lead to some ‘optimal’ policy since, as theoreticians frequently point out, charging systems effectively apply the same unit cost of disposal irrespective of the nature of the materials being thrown away.

483. In considering the pros and cons of different schemes, Porter concludes:

*All the practical complications of the three schemes can be summarized easily. Any ADF would ideally be equal to some  $a_{ij}$ , where  $i$  is the product (or package) and  $j$  the place where it is sold (or more precisely, where it will be disposed of). But in fact, it would be difficult to vary the ADF by place, so it would end up being  $a_i$ , varying across products (and packages) but not across places. Similarly any trash collection charge ( $t$ ) or recycling collection charge/refund ( $r$ ) would ideally be equal to some  $t_{ij}$  or  $r_{ij}$ , also varying across product and place. But in fact, it is difficult to vary them across products since that would require extensive household sorting or lengthy collector examination, so these would end up being  $t_j$  and  $r_j$ , varying across places but not across products. In a sentence, it is in practice impossible to achieve a fully first-best policy – close is as close as we can come.<sup>97</sup>*

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96. For reviews of the literature, see Bartelings (2003), Linderhof, *et al.* (2001), Skinner and Fullerton (1999) and Palmer and Walls (1999).

97. See Porter (2004).

484. In principle, there is qualified support for approaches based upon charging households at the margin for waste generation, with the issue of dumping being, apparently, the one which most pre-occupies the writers, even though empirical evidence does not support the view that this is always a *major* problem.

485. The general case for charging is quite simple. Where households are confronted with a marginal price for waste services which is zero, households generate too much waste. They are free to do too much of whatever is on offer to them (disposal of refuse, set-out of recyclables, and set out of compostables). The question then is how, in the practical (as opposed to theoretical) world, should these market failures be addressed?

486. In the literature seeking to understand the optimal policy mix, a crucial element which is almost universally lacking is a clear comprehension of the role of service provision in delivering the requisite objectives. In many theoretical papers, it is not even assumed (one has to infer that it is being assumed) that recycling services are 'there' as and when they need to be. This is a serious shortcoming of the overwhelming majority of economic analyses of the 'problems' identified by various studies of this issue. Markets for the supply of recycling services are not of a nature likely to lead to their instantaneous supply, and they are not always of a nature likely to be switched on or off on tap unless a) the market price for materials covers the cost of collection, and b) the would-be collector has the right (as well as the revenue-driven inclination) to collect the materials from the household.

487. Most municipalities faced with the problem 'what to do with municipal waste' have to make decisions concerning the nature of the services they will provide. Some fundamental issues face them, or the providers whom they might ask to deliver services. Probably, the issue they must confront at the outset is which materials they will target for separate collection and when. Once this decision has been made, and it may well be made on an iterative basis taking into account total system costs (or, in some jurisdictions, the least cost way of delivering a target), then decisions have to be made concerning containment methods, vehicles, collection frequencies, need for sortation, nature of any biowaste treatment required, etc. Waste collection vehicles, should be tailored for the purpose for which they are to be used taking into account the nature of the materials being collected, and the requirements for their subsequent treatment.<sup>98</sup> Hence, choices have to be made. Since a fundamental piece of the jigsaw is the vehicles, most municipalities consider their collection systems in cycles of five to seven years (reflecting the typical life-time for the vehicle). Collection systems can be ossified somewhat where investments are made in dedicated machinery for sortation (or the corollary of this is that the greater the investment in 'system specific equipment' with a long operating life, the greater will be the costs of any change).

488. What services should be provided? How will services be funded? How should costs be recovered? Who should pay for what aspect of the total costs? These are critical public policy issues. They raise issues concerning the linkages between unit charging and both producer responsibility (PR) schemes, and approaches to dealing with those materials for which PR is less appropriate.

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98. Porter (2005) presents a simplified exposition of the costs of recycling. Simplified or not, he makes the fundamental error (from an operations perspective) of assuming that materials to be compacted would be collected in a vehicle of the same cost as materials which are not to be compacted. Why choose a compaction vehicle (with the additional cost – sometimes 300% more!) to collect material which is not being compacted? This rather renders the logic of the simplified presentation out of the water. Food waste can either be collected within refuse on refuse vehicles costing €175,000, or separately using non-compacting trucks costing €26,000. The former is usually crewed with a driver plus one to three crew (depending upon round, collection frequency etc.), the latter would rarely be occupied by anyone other than the driver. For this reason, it is possible to collect dense (around 70% moisture) food waste at about twice the frequency of refuse at equivalent cost. Consequently, it is possible to run a service with a weekly collection of food waste and a fortnightly collection of refuse for the same cost as a weekly collection of refuse. This does happen (in the real world).

489. There is a role for cost-benefit analysis in informing the decisions concerning which materials should or should not be considered as appropriate for collection for subsequent recycling, but these services cannot be turned on and off like a tap, and they function as part of a *dynamic* system. This has been discussed above. One question that remains, as far as we can see, unposed by those who analyse the optimal policy mix is whether the possibility of illegal dumping might, in the context of charging, justify broadening the scope and enhancing the convenience of a given recycling system.

490. This might not be so foolish as it at first sounds since separate collection of specific items could, for example, reduce net social costs of residual waste collection, either through a) changing the nature of the input material to treatment facilities (and hence, either the necessary abatement costs, or, more likely, the actual plant emissions – separate collection of, for example, batteries, or fluorescent lamps might be an example), or b) through allowing a reduction in collection frequencies for residual waste (as, for example, might be the case with collecting low bulk density materials such as plastic bottles). Another reason relates to householder response to recycling systems. Generally, when materials are added to a kerbside collection system, captures of all materials (not just the ones added) tend to increase. Contrary to most of the theoretical discussion on recycling, this may have the effect of reducing the unit costs of the materials already being targeted for collection (since, like most operations, recycling systems exhibit economies of scale – too many economists look at the problem from the perspective of ‘what is left’ rather than seeking to understand the efficiency of the system in place to capture materials).

491. The key point here is that one is seeking to understand the best policy with which to address a dynamic system which, because of the contractual issues involved, is significantly conditioned by varying degrees of rigidity owing to the nature of contractual relationships and the investment cycle for different types of equipment / vehicle / treatment facility.

### **A.9.2 Packaging materials**

492. Different countries around the world make use of different approaches to dealing with packaging waste. Increasingly, the concept (albeit in various guises) of producer responsibility has gained currency.

493. Within Europe, Member States are required to achieve specific targets for packaging recovery and recycling though the mechanisms they use vary by Member State. Many countries make use of ‘green dot’ organisations to arrange for the collection and recycling and / or recovery of packaging materials. In the United Kingdom, a system of tradable compliance credits is used. In the Netherlands, a voluntary agreement exists between municipalities and the government to achieve targets (and a body exists to guarantee minimum materials prices), and in Denmark, a system of deposit refunds and packaging taxes is used.

494. The implications of the different systems for local authorities are quite different. In the UK, Denmark and the Netherlands, it would appear that the burden of funding for municipal waste collection, including that of packaging, falls primarily on the local authority itself where it chooses to collect packaging materials.<sup>99</sup> In Green Dot schemes, local authorities receive either:

- Financial support covering all the costs of packaging waste collection;

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99. In the UK, local authorities may benefit to a limited degree through an increase in the price for recycled material relative to a counterfactual situation in which the policy did not exist. Those reprocessors with the right to issue packaging recovery notes, or PRNs, may maintain materials prices higher than they otherwise would to encourage supply of material, especially at times when PRNs are in short supply relative to demand (and this is affected by annual decisions by Government concerning the targets to be met in any given year). In Denmark, it might be argued that the system reduces the quantity of material to be managed by the local authorities (since more is likely to be kept within the returnable bottle route rather than the one-trip container route).

- Financial support covering some of the costs of packaging waste collection (and in some cases, the aim is to set the level equal to the incremental costs above and beyond the costs of refuse collection and disposal); or
- The provision of the service itself through an organisation collecting on behalf of a producer responsibility organisation.

495. Consequently, the approaches adopted vary in terms of their budgetary implications for local authorities.

496. At least in theory (if not always in practice), the source of funding should not dramatically affect the costs of meeting a given target. Consequently, this is a question which concerns the incidence of these costs, and the degree to which producers and consumers may, as a consequence of the way these costs are borne, be faced with incentives to change their behaviour. Other things being equal, the less the local authority benefits (either from revenue or services), then the more reliant producers are upon local authorities to provide the services which will ensure that relevant objectives are met.

497. This then raises questions as to how systems of charging might relate to the nature of service provision, and to the role played by producers in funding service provision.

#### ***A.9.2.1 Local authority remunerated completely***

498. Let us take, first of all, the situation where a local authority is effectively remunerated completely for all the costs of packaging collection. There are two ways in which this could happen:

- A PRO collects funds from member organisations on a material-by-material basis and these are used to support the costs of recycling in local authorities; or
- An ADF is levied on products at different rates reflecting their costs of collection.

499. In this situation, local authorities are clearly likely to put in place systems for packaging materials recovery since they avoid the costs of collection of refuse and disposal for materials which are recycled.

500. If recycling systems are effectively zero cost to the authority, the local authority will have to cover the costs of refuse collection and residual waste treatment / disposal, as well as the costs of biowaste collection and treatment. For this reason, the local authority is likely to seek to ensure that:

- households who *can* recycle *do* recycle (they have an incentive to use the recycling service);
- households who are provided with a biowaste collection make use of it (without disincentivising home composting – see below); and
- the costs of collection of refuse and disposal fall, as far as possible, upon those who generate most refuse.

501. This is where charging systems have a role to play. The combination of:

- Levies paid by producers to cover collection costs; and
- Charging systems reflecting the private and external costs of treatment / disposal

can help to ensure that householders are confronted with incentives to recycle, as well as incentives to reduce waste at the margin.

502. From a local authority perspective, implementing charging systems which internalise the social costs of disposal may be somewhat awkward unless these costs are already internalised at a higher level of

government (for example, through landfill taxes, or incineration taxes, or a wider range of emissions taxes). What is nominally framed as a ‘cost recovery charging system’ may be perceived a system of taxation for the purposes of raising revenue. Indeed, there is a risk that local authorities would transform a cost recovery charge into a source of tax revenue.

#### ***A.9.2.2 Local authority not remunerated at all***

503. Where local authorities are not in receipt of any services or revenue through the implementation of producer responsibility, the local authority faces a fundamental question as to whether or not it collects packaging materials. The question is not a straightforward one.

504. A number of economists report ‘the costs of recycling’ as though these can be represented by a single ‘per tonne’ cost in a specific location independent of the fundamental question ‘recycling of what?’ For most local authorities operating to minimise the private costs (as opposed to the net social costs) of waste management, then in the absence of any policy instruments to influence these decisions, the questions of ‘whether to recycle?’ and ‘what to recycle?’ assume considerable significance.

505. The most prevalent packaging materials in the municipal waste stream are paper and cardboard packaging, glass bottles and jars, food and beverage cans, plastic bottles, plastic films and rigid plastic containers. To collect any one of these materials independently of others would incur costs for the local authority. Whether the costs, and associated revenues from material sales, would be offset by avoided costs of refuse collection and disposal depends upon the material under consideration, and the approach to collection (whether through bring banks or kerbside collection). It also depends critically upon the marginal disposal costs. For materials such as plastics, the costs of kerbside collection plus sorting are known to be high. Bring banks for aluminium cans, on the other hand, may generate revenue which largely offsets the pick up costs. Other things being equal, a local authority seeking to minimise the costs of waste management will probably only opt for a comprehensive kerbside collection of packaging materials where the marginal costs of disposal are relatively high.

506. In short, the fact that the collection scheme is not supported by external revenues makes it:

- Less likely that the authority will invest in comprehensive collection systems;
- More likely that it would suffer disbenefits from dumping as a side-effect of any efforts to introduce variable charging systems, and so less likely that such charging systems will be introduced as a result (and less wise for the local authority concerned);
- More likely, as a consequence, that:
  - Waste generation will continue to be above what is socially desirable; and
  - Recycling will stay at low levels; and
  - The burden of cost recovery falls upon the local authority as a whole (through, for example, property taxes or other local taxes).

507. In addition, because there is no link between producers and what occurs at the end of the product’s life, there is no clear mechanism for ‘producer responsibility’. Consequently, unless other instruments are in place, the producers’ behaviour is unlikely to be greatly affected, if only because there is no incentive for the local authority to arrange for the provision of any new services.

508. Disposal taxes could be used to influence the decisions of local authorities. However, depending upon the gap between the costs of disposal and the cost of recycling, the tax rates may need to be relatively high to induce authorities to instigate collection of packaging at the kerbside. In the absence of a revenue source to internalise external benefits from recycling, this might be justified through reference to the desire to eliminate the gap between recycling and disposal costs by taxing disposal at a level equal to the differential external cost between recycling and disposal. This figure varies considerably across materials,

but it could actually be quite high for, for example, metal packaging. Since landfill taxes are relatively blunt instruments, and cannot readily be applied on the basis of the detailed composition of the waste being landfilled, it seems likely that the tax rate required to achieve this would be in excess of what could justifiably be applied for other materials.

509. Under the UK system, the local authorities may, in times where the supply of materials relative to demand is tight, benefit from higher prices for materials supported by the higher price paid for the PRNs. However, the PRN price is effectively determined by the need to draw forward ‘marginal tonnes’ of packaging materials. Consequently, unless the compliance schemes enter into some form of relationship with local authorities, the (potentially) temporary increase in revenue from higher PRN prices is unlikely, by itself, to motivate local authorities to take the necessary investment decisions to implement the infrastructure required to deliver additional material. In practice, compliance schemes are likely to have to make some form of financial payment to local authorities. Indeed, this is likely to be the cost-minimising approach for all involved since in the absence of a direct injection of funds to support packaging recycling, the alternative would be a higher PRN price, and this increases the costs associated with all materials being recycled (not just the additional materials that need to be collected to meet a specific target).

#### ***A.9.2.3 Discussion***

510. In the above situation, we have considered two possible extremes. In the first, there is a direct financial link between local authorities and producers. This can provide local authorities with the incentive to collect packaging materials, or alternatively, the service is delivered within the local authority area at zero cost. At the other extreme, where local authorities receive no direct budgetary support, there is no reason why they should provide additional services to local residents.

511. In the literature, there is much discussion about what might be ‘optimal’ in this area of public policy. The argument usually shifts in favour of incentive based instruments rather than target based ones. Part of the reason relates to standard arguments in respect of efficiency. However, the complexity of the cost-benefit analysis underpinning the issue of, for example, packaging collection does not lend itself to clear statements (other than in theory) as to what the levels of fees and refunds should be (and in what circumstances). The analysis is far from straightforward since the system being examined is complex and dynamic. Furthermore, the necessary up-to-date data concerning the environmental impacts of different processes is not readily available.

512. If Advanced Disposal fees should be paid to cover the costs of recycling of the material placed on the market, should they cover the costs everywhere and in all circumstances? How should the cost-benefit test be applied in specific circumstances?

513. An interesting instrument in this regard might be the use of tendering schemes (such as those used in some contexts in agri-environmental policy). Under such a policy, PROs could (and they can do so now) invite tenders from local authorities for the delivery of packaging materials (possibly in different forms – mixed or separated). The bids would necessarily be ‘system specific’ (so local authorities might bid with different unit prices for one-material, two-material, three-material etc. collection). The lowest cost tenders would be more likely to be chosen for support. The question then would be ‘to what level would the tenders be supported?’ Arguably, the tenders should be supported up to a level equal to the external benefits of the recycling process. Contrary to what is often suggested, for many materials, this might even suggest a need for much *more* comprehensive infrastructure than is the case today in many countries.<sup>100</sup> For other materials,

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100. A recent UK study suggested that the addition of metal cans to an existing kerbside recycling system can result in a reduction in private costs of the collection system (See EcoAlternatives (2004)). Set alongside the external benefits of recycling metals – for aluminium, especially, these are significantly positive in the literature (see Section A.3.4) – this suggests a sub-optimal level of investment in the recycling of metal packaging. Given the presence of cans in litter, it also suggests that recycling from segregated litter bins

it might suggest over-investment in some countries, though before one could make this statement with certainty, one would probably need to be rather more confident in the analysis of external costs and benefits than existing studies and information allow us to be.

### **A.9.3 Biowaste collections and home composting**

514. In those jurisdictions where recycling targets exist, local authorities can choose from some quick wins, and some more difficult gains, in their attempt to improve their performance against targets. Generally, in OECD countries, the majority of household waste is composed of paper and card, kitchen waste and garden waste (yard waste as it is referred to in the United States). Of these fractions, garden waste is the one which is most likely to be affected by the nature of the collection system put in place.

515. The household biowaste fraction is one of the fractions of municipal which has to be considered most carefully where municipal waste management systems are being considered. The dynamics of the interaction between different components of the system, and some components which either are, or appear to be, outside it, have to be considered especially carefully.

516. For the sake of trying to enhance our understanding, we may consider the system of biowaste generation in a given household as two separate, though in some households, related, systems for the generation of kitchen wastes and of garden wastes. Alongside this, other biowastes are also generated.<sup>101</sup>

#### **A.9.3.1 Garden waste**

517. The generation of garden wastes might typically be associated with, amongst other things:

- Size of garden and its nature (i.e. how much is planted to lawn, bedding, pot plants, shrubs, etc.);
- The types of plants grown (fast, or slow growing);
- The weather in a given year (affecting plant growth); and
- How 'tidy' the gardener keeps the garden.

518. In countries with a temperate climate, such as that experienced in the UK, garden waste arisings tend to be highly seasonal. The seasonality is itself an issue of some significance for collection and treatment systems.

519. The range of management routes includes legal and illegal ones. For example:

- Home composting (taken to include leaf mould, any worm bins etc.);
- Grass cycling (where clippings are left on the lawn) and grass mulching (where clippings are used on flower beds);
- Container-parks (where the material may be sent to garden waste skips, or general skips, depending upon how well the site is managed and operated);
- Biowaste containers (where this accepts garden waste);

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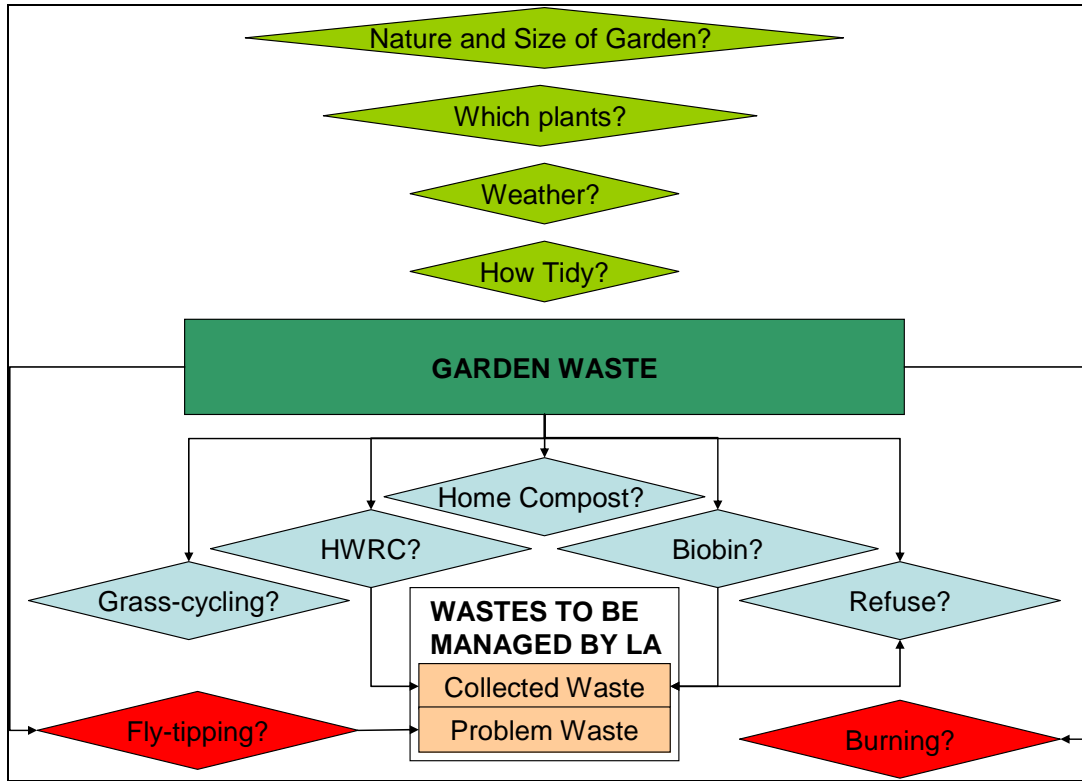
should also be given greater attention. Interestingly, beverage can manufacturers are increasingly placing their faith in treatments for residual waste (such as mechanical biological treatment) to deliver the required material to meet packaging targets.

101. The subsequent remarks are mainly based on experiences and perspectives in United Kingdom. However, discussions over many years suggest that the principles are similar across countries, and that much of the discussion is applicable beyond the UK.

- Refuse collection (and systems may or may not attempt to exclude garden wastes. In some systems, residents are asked to pay for sacks for garden waste collection, and this is co-collected with refuse);
- Fly-tipping; and
- Burning.

520. These options are shown in Figure 31 below.

**Figure 31. Factors influencing production of, and fate of garden wastes**



521. The point which is understood all too infrequently is that this is a dynamic system. People’s behaviour in terms of generation of waste can be affected by the collection system available to them. Their choice of management route is also affected by the collection system available to them. The consequence of this is that the oft-cited statement of local authority waste managers – that they cannot do much to influence waste arisings – is incorrect where one considers the quantity of biowaste collected.

522. This is an issue which we discuss in more detail below.

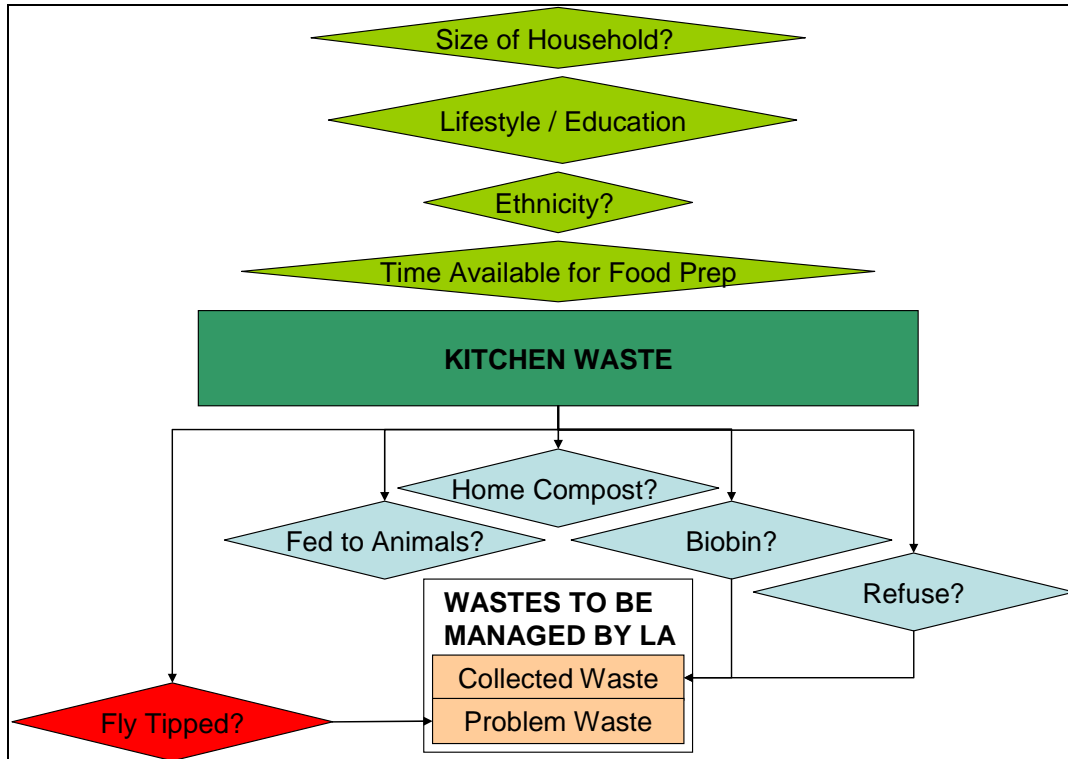
**A.9.3.2 Kitchen Waste**

523. With kitchen waste, the issues are slightly different. Whereas garden waste generation presumes the existence of a garden, or at very least, some plants, all households generate some kitchen wastes. The generation of kitchen wastes includes both uncooked and cooked food materials. The size of the household, as well as lifestyle, and issues affecting the time available to prepare meals, are likely to affect the magnitude of kitchen waste arisings. The time which is available for / spent on cooking meals as opposed to eating out / buying pre-cooked meals is likely to have some influence on kitchen waste arisings. Ethnicity

may also be an important factor since cultural norms may influence the likelihood of meals being home-prepared.

524. Kitchen wastes can be managed in similar ways to garden wastes. However, some routes are less likely (such as container-park s) whereas others are less likely for certain types of household (such as home composting in households with no garden, though worm bins would be a possibility in these situations). Some kitchen wastes may, despite the supposed questionable legality of this, be fed to animals (it is difficult, after all, to see how any law on this could be enforced, and whilst such laws may, in some countries, affect every house in the land in principle, in practice, knowledge and enforcement of it tends to be restricted to specialists).

**Figure 32. Factors influencing production of, and fate of kitchen wastes**



Note: According to Article 22 of Regulation (EC) No 1774/2002 on animal by-products, the feeding of farmed animals with catering waste is forbidden within the European Union.

### A.9.3.3 Other biowastes

525. There are a range of biowastes which do not fall readily under the heading of either garden waste, or kitchen waste. They include, for example:

- Faeces from pets, including some materials used as cat litter;
- Faeces from humans;
- Residues from carpet cleaning;
- Wood; and
- Corks.

526. These materials are all, in principle, compostable and / or digestible, some being more easily dealt with in one or other treatment than others. Wood, depending upon the form in which it arises may be better

dealt with through other treatments, whilst human faeces do not normally arise in household waste unless where associated with nappy usage.

527. Other materials not normally considered as biowaste but which are readily dealt with through biological treatments include cardboard. This is already collected in some schemes for composting, whilst in some European municipalities, cardboard, including soiled materials such as pizza boxes, is collected for subsequent anaerobic digestion. Cardboard is particularly interesting in this latter respect as it is a source of considerable quantities of biogas, which can be used to generate energy.

528. Finally, in the context of many waste composition analyses, it is worth pointing out that the category described as 'fines' can often consist of large proportions of biowaste. As the 'left-over' fraction in waste composition analysis, it is also the fraction where many food left-overs can be found. The significance of this observation obviously depends partly upon the size of the fines fraction after all the rest of the material has been sorted. According to the different approaches adopted to analysing waste components, the fines fraction tends to vary considerably in the proportion of waste which they account for. It is not unusual for 50% or so of the fines fraction to be putrescible material of one or other variety.

#### ***A.9.3.4 Collecting biowastes***

529. Where local authorities choose to collect biowastes, a key issue is how they deal with garden wastes. In general, the more convenient is the collection of garden waste, then the more garden waste will be delivered into the collection system and the less will be processed at home (through home composting).

530. Where garden wastes are concerned, there are two extreme approaches which local authorities can take to garden waste. On the one hand, they can seek to restrict the delivery of garden waste into the collection system through one or more of the following:

- Restricting the size of biowaste containers;
- Seeking to restrict the delivery of garden waste into refuse;
- Seeking to restrict 'side waste' (the delivery of waste with a volume in excess of a container provided to the household);
- Charging for biowaste collections; and
- Promoting home composting.

531. At the other extreme, local authorities can seek to maximise the delivery of garden waste into the waste stream. This is often the case in those local authorities faced with targets for recycling and composting. They can do this by:

- Offering large containers for separately collected waste;
- Not charging for the biowaste container (and charging for the residual);<sup>102</sup> and
- Not promoting home composting (or doing so only loosely).

532. The difference in approach is often instantly recognisable. In suburban and rural authorities where garden waste collections are maximised, the amount of waste collected at the kerbside is frequently around 200kg per household greater than in those authorities where free garden waste collections are not in place. Some of this is usually associated with material which might otherwise have been delivered to container-park s / civic amenity sites. However, a significant proportion of this is usually 'new material', reflecting to

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102. This is the situation where the phenomenon of 'waste leakage' is most likely.

some extent the fact that some households ‘give up’ home composting, and also, the fact that when a free garden waste collection is on offer, people tidy their gardens more than they otherwise would.<sup>103</sup>

533. Research in the UK has been undertaken with the aim of understanding how the activity of home composting affects collected waste. This work suggests that the quantities of waste being composted by active participants is higher than was previously thought, especially in areas with garden sizes averaging over 200m<sup>2</sup>. Here, an estimated 340kg of material per household per annum is dealt with through home composting. It is thought that 160kg of this might otherwise be collected as dustbin waste, whilst the remainder is material which would otherwise be taken to a CA site (see Table 43.). For areas with smaller gardens (less than 200m<sup>2</sup>), the figures are 180kg per annum and 100kg respectively. The national average figures suggest home composting households are reducing the input to the residual waste bin by around 115kg per annum on average.

534. The important point here is that quite apart from any ‘new’ arisings from a latent garden waste fraction (i.e. that which households might place into a biowaste container which they do not currently collect for home composting), where people are discouraged from home composting, even if only ‘passively’, the potential for increased deliveries into the formal collection system clearly exists. Background rates of home composting may be relatively high – in some cases, greater than 30%. Providing convenient means of setting out garden waste for separate collection has the effect of reducing the commitment to home composting, effectively pulling material out of people’s back gardens and into the collection system, thereby implying both increased collection and treatment costs.

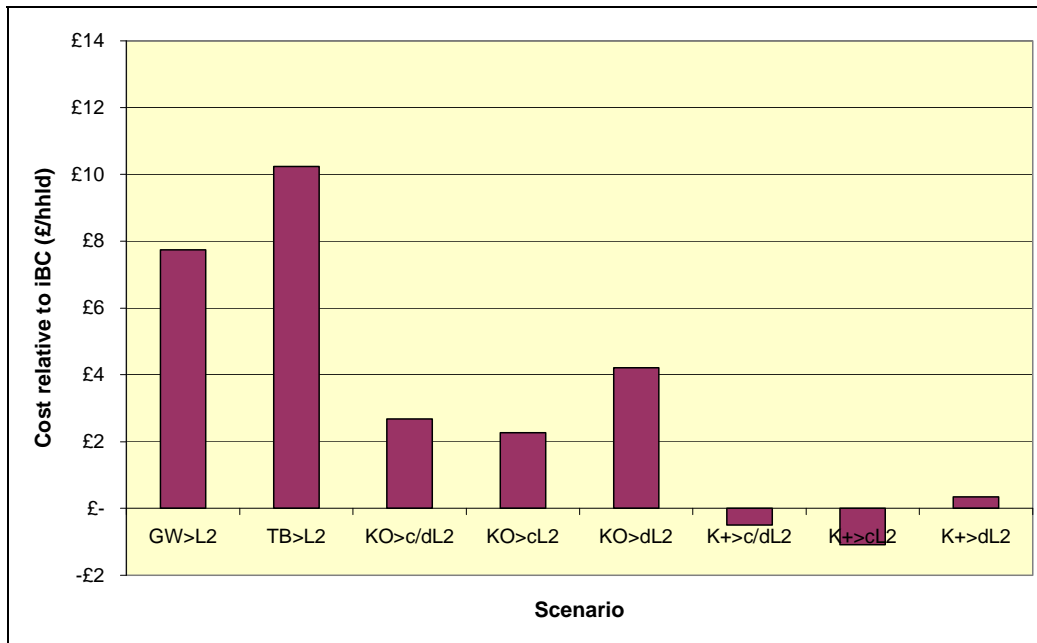
535. We ourselves have modelled the impact on whole system costs in the UK of systems which target kitchen waste against systems which target either garden waste only, or kitchen and garden waste. The cost differentials are shown in Figure 33. These cost differentials are relative to a Base Case in which no biowaste is collected. The collection scenarios are described in Table 44.

**Table 43. Effects of home composting on biowaste delivered through different collection routes**  
Reduction in number of kg per household per year

Reduction in:	Results based on questionnaires & waste analysis		Results based on district models (based on DEFRA local authority statistics 2003/04)		
			Overall model	Average garden size greater than 200m <sup>2</sup>	Average garden size less than 200m <sup>2</sup>
Dustbin waste (total)	84		115	160	100
Kitchen waste in dustbin	WRAP bins v Non-participants	42			
	Non WRAP bins v Non-participants	24			
Dustbin waste + CA waste			220	340	180

103. For example, see some of the analysis in Eunomia (2004a). See also Favoino, Ricci and de Fontanals (2003).

**Figure 33. Cost differentials relative to the base case**  
Disposal costs £60 per tonne



**Table 44. Collection Model Description Summaries**  
Gardens larger than 200 m2

	Dry recycling	Biowaste	Refuse	Costs
>200 base case	Fortnightly 240l bin, capture norm, 5% reject	None	Weekly 240l	
>200 garden only	Fortnightly 240l bin, capture high, 5% reject	Fortnightly (alternating) 240l	Fortnightly (alternating) 240l	£19/t open air windrow
>200 all biowaste	Fortnightly 240l bin, capture high, 5% reject	Fortnightly (alternating) 240l for those with gardens, kerbside bucket for those without.	Fortnightly (alternating) 240l	£35/t in vessel composting (IVC)
>200 kitchen only (kitchen AD, HWRC green windrow)	Fortnightly 240l bin, capture high, 5% reject	Weekly, kitchen caddy & kerbside bucket	Fortnightly (alternating) 240l	£60/t AD, £19 windrow → £42.70
>200 kitchen only (IVC)	Fortnightly 240l bin, capture high, 5% reject	Weekly, kitchen caddy & kerbside bucket	Fortnightly (alternating) 240l	£40/t IVC
>200 kitchen plus (kitchen AD, HWRC green windrow)	Fortnightly 240l bin, capture high, 5% reject	Weekly, kitchen caddy & kerbside bucket. More home composting.	Fortnightly (alternating) 240l	£60/t AD, £19 windrow → £44.05
>200 kitchen plus (IVC)	Fortnightly 240l bin, capture high, 5% reject	Weekly, kitchen caddy & kerbside bucket. More home composting.	Fortnightly (alternating) 240l	£40/t IVC

536. As disposal costs rise, the avoided disposal costs increase. Consequently, the incremental costs are reduced to £8 to £10 per household in the systems targeting garden waste and £2 to £4 per household in systems targeting kitchen waste. Where home composting is successfully promoted, the cost differential becomes negative, possibly generating a potential saving of up to £2 per household.

537. This suggests a cost differential across systems which target garden waste and those which do not of the order £10 per household per annum.

*A.9.3.5 The role of DVR systems*

538. Our experience, and much in other countries, is that systems which collect garden waste free of charge are likely to lead to increased quantities of material being delivered into the collection system.<sup>104</sup> This has cost implications and, as long as home composting is carried out well, little environmental gain results from the movement of materials from the garden into the formal collection and treatment system.

539. Once garden waste collections are in place, it is not straightforward to 'take them away', partly because they tend to be well-, if not over-, utilised. In these circumstances, the question becomes one of how to constrain costs through constraining delivery of garden waste into the collection system. Charging is one potentially effective route for doing this.

540. The Schweinfurt case study provides some instructive experience of this nature, as does (to a lesser degree) the experience in Ghent. In both cases, the charging schemes include a charge for the biowaste fraction. In both cases, there is considerable sensitivity to the issue of the relationship between the charge for biowaste collection and the charge for refuse collection.

541. For example, in the Schweinfurt scheme, if the charges for refuse collection and biowaste collection had been set in line with the treatment costs for each, the cost differentials would have been very high. The Council was concerned that this would simply lead to contamination of the biowaste container. Hence, the rate for the biowaste container was increased to reflect this concern.

542. In Ghent, the differential between the cost of refuse and biowaste collection are seen as a key issue in, on the one hand, incentivising separate collection and, at the same time, giving some incentive to home compost (to constrain collection).

543. In both cases, the impact on the biowaste has been significant. In Schweinfurt, the charging system has led to a significant reduction in the quantity of biowaste collected and this has been attributed to increases in home composting. In Ghent, the amount collected separately has actually increased, but the quantity collected separately (at kerbside) has dropped, whilst the quantity collected at the container-park s has increased.

544. This suggests that pricing the biowaste container can have a significant effect on the way biowaste, and in particular, garden waste, is collected. However, whilst there is much in the literature that purports to define own- and cross-price elasticities of demand for refuse services, knowledge concerning the magnitude of, and factors conditioning, price responsiveness of garden waste collections is quite limited.

545. It is interesting to note also that where kitchen waste only is collected, many municipalities seek to encourage home composting. However, it is not so easy to do this (for obvious reasons) since there is a need to assess whether a household is really home composting, and whether the activity is being properly carried out. Even so, in the case of Torrelles de Llobregat, those actively engaged in home composting in the previous year were to be – it is not clear whether the system was operating for long enough - given a 50% discount on the flat rate fee for waste collection. Similar approaches are adopted in Italian municipalities where home composting occurs in the context of charging schemes.

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104. By way of example, we recall our visit to Ghent where one of the managers of the service lamented that 'my biggest regret is that we ever gave households a 240l wheeled bin for biowaste'.

## GLOSSARY OF TERMS

***Economic costs.*** The economist's notion of costs, which is used in cost-benefit analysis, goes wider than simply the lay person's notion of monetary expenditure. Economic costs could include both monetary and non-monetary costs. Thus, for example, the cost of disposing of waste through incineration could include both the 'private', monetary costs of building and operating the incinerator, and non-monetary costs, such as the impact of the emissions from the incinerator on the health of local residents.

***Environmental costs.*** Costs connected with the actual or potential deterioration of natural assets due to economic activities. Such costs can be viewed from two different perspectives, namely as (a) costs caused, that is, costs associated with economic units actually or potentially causing environmental deterioration by their own activities or as (b) costs borne, that is, costs incurred by economic units independently of whether they have actually caused the environmental impacts.

***External costs.*** Costs incurred as a result of individual decisions, but which are borne by an individual other than the person making the decision. For example, a private landfill operator which allows the site to contaminate groundwater may impose costs on neighbouring residents or businesses, in terms of health damage, the costs of water purification, or the costs of obtaining alternative uncontaminated sources.

***Externality.*** The effects of a production or consumption decision which are experienced by individuals or businesses which did not consent in the initial decision. Externalities may be either "positive" or "negative". A *negative externality* is one in which costs are imposed on other people, as when a person dumps litter in the countryside, imposing (non-monetary) costs on others whose aesthetic sense is disturbed by the litter, and/or (monetary) clean-up costs on the landowner or public authorities. A *positive externality* is one in which benefits are experienced by others. For example, many firms may be able to benefit from the results of research expenditures by a recycling firm, if patent protection is incomplete.

***Private costs.*** The costs incurred by the individual decision-maker. These are the costs which would be taken into account by individuals motivated by self-interest, or by businesses aiming to maximise profit. Private cost may be contrasted with a wider measure of costs, such as social cost, which includes costs ("external costs") borne by individuals other than the decision-maker.

***Internalisation of externalities.*** Incorporation of the economic value of any external costs into the market decision making process through pricing or regulatory interventions. In the narrow sense, internalisation can be achieved by charging polluters with the external costs of the pollution generated by them.