

## Pay-as-you-throw (PAYT) scheme in Schweinfurt

### Bin volume, frequency & weight-based scheme



### 1. Summary

Country/Geographical area	Germany, Landkreis Schweinfurt (county)
Level of implementation	local
Scale	Roll-out
Waste fraction	Municipal waste
Target Audience	116,000 inhabitants of the county
Objective	to reduce the quantity of waste for disposal without changing the existing system, but by improving incentives for improved management / reduction of waste by households.
Initiator/coordinator	Landkreis Schweinfurt
Other key actors involved	-
Duration	Since 1997
Number in Mapping report	108 (replaces other PAYT case study)
Drafted by	IBGE 20/6/2011
Contacts / URLs	<p>Sources: EUNOMIA « A Comparative Study on Economic Instruments Promoting Waste Prevention Final Report to Bruxelles Environnement » Dr Dominic Hogg, Dr Chris Sherrington, Thomas Vergunst, 8 November 2011.</p> <ul style="list-style-type: none"> <li>Abfallwirtschaft Landkreis Schweinfurt: <a href="http://www.ihr-umweltpartner.de/Gebuehren_und_Verwiegung.html">www.ihr-umweltpartner.de/Gebuehren_und_Verwiegung.html</a></li> </ul>

## 2. Context

In Germany, municipalities have responsibility for waste collection, but in Bavaria, collection tends to be organised on a county wide basis. The county of Landkreis Schweinfurt has a population of 116,000 inhabitants. The area excludes the main town, and covers only the peri-urban area surrounding it.

In the late 1980s, the system started changing from a one bin to a *three bin system*. By 1994, the doorstep collection of residual waste, biowaste and packaging fractions, supported by separate collections for glass, cans, and paper and card at bring sites, was delivering a recycling rate of 58.6%.

At this time, households only paid for residual waste collections. The system was based around a purely volume-based scheme where households paid an annual subscription based upon the volume of the bin they chose. This was therefore effectively fixed for the year, and variable only through that ‘one-off’ decision.



## 3. Strategy

### Objectives

In 1997, the County decided it wanted to take an additional step. It wanted to reduce the quantity of waste for disposal. It was not keen to change the existing system, but was interested in improving incentives for improved management / reduction of waste by households.

In the year 2000, incineration of refuse would have cost the county €250 per tonne. The landfilling of waste at the time cost €80 per tonne. Before the Pay as you throw scheme (also referred to PAYT or as Direct & Variable Rate, DVR), a household using a 120l bin was charged €170 per year. The fee covered all the costs of waste management, including fortnightly refuse collection and fortnightly collection of the biotonne (the biowaste container). Costs of collecting the Packaging fraction (handled by Dual System Deutschland) were not covered by the municipality (this was covered by producer fees). It was expected that without any change in the performance of the system, the fee would rise to €210 per household.

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).

The system is intended to take into account 3 aspects: bin size, set-out frequency and weight. In this way, there is an up-front choice to be made to reduce bin volume, an incentive to reduce set-out rates (so as to improve collection logistics) and a weight-based element to reflect the marginal benefits of avoided disposal.

### Preconditions

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; and
- c. Weight based.

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

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 makes the system's objectives all the more challenging given the already low level of residual waste in the system, and illustrates the commitment of the staff to the project.

## **Procedure**

### **Preparation for the Charging System**

In 1997, a trial across a community of 3000 persons was carried out. This enabled knowledge to be gained about the system and any shortcomings. Interestingly, it was not so straightforward to start the trial. The intention was to implement the whole system, including the new charging system (see below) in this trial. The first community approached complained and did not want to be the group being experimented upon. The second community happened to be the one in which the political leader of the county lived, and this community was willing to be the trial area.

Successful trials led to a decision being taken, in 1998, to introduce the scheme across the county. The scheme was not suddenly 'rolled out', however. Across the 29 component communities, information and publicity campaigns were undertaken. In each community, a 13 week programme was implemented. Fourteen months elapsed between the decision being made (1998) and the scheme being rolled out across the whole county (2000).

### **Pre-implementation Issues**

There were three major concerns that managers had prior to the scheme's introduction. They were:

- a) Concerns that some fractions which should have been set out as residual waste would contaminate separately collected fractions;
- b) Concerns (expressed by households) that users would fill up their neighbours' bins; and
- c) Concerns regarding fly-tipping.

Social issues were not considered a major concern since an aim was to make charging fair, and since also, one of the aims was to reduce costs to householders.

The issues were addressed in the following way:

1. With regard to the issue of **contamination**, the charging structure was deliberately designed so as not to generate enormous differentials between the residual waste charge, and that for biowaste. Since the other collected fraction was paid for through purchases of products, there was no need to charge for these fractions. The intention was to apply the weight-based element of the charges only

on the basis of the costs of incineration of residual waste, and the costs of composting of biowaste. On the basis of anticipated costs, this would have led to charges for residual waste of €250/tonne, or €0.25 /kg, and charges for biowaste collection of €30/tonne, or €0.03 /kg. It was felt that this level of differential was too high, and could lead to contamination of the biowaste collection. Hence, a decision was made to set the biowaste weight-based charge at 60% of that for residual waste. Note also that the charging structure was such that the weight-based element of the charging system did not constitute a major proportion of the overall charge paid by householders (see below).

The other approach taken to addressing issues of contamination was that of free bulky waste collection. Prior to the system's introduction, this service was provided to all householders 2 times per week. After the system was introduced, the collections were provided only on request, and again, 2 times per annum. The aim was to enable some control to be exercised over the collection of this fraction - since one would know to whom the waste belonged, the possibility that residual waste (or other materials such as biowaste) might be delivered into the bulky waste collection was reduced.

2. With regard to the issue of **neighbours using the bins of others**, a gravity lock was offered to households as an optional extra, this at a cost of €0.50 per month (or €1 per month for both the residual waste and biowaste bins). The charge remains at this level today. This is sufficient to cover the cost of such locks at about €40 each. Before the system was implemented, households were given the opportunity to select this option so that when bins were delivered, the nature of the bin reflected that choice. There has been strong demand for this system - approximately 40% of households elected for such bins.



3. Regarding **illegal waste disposal**, it was felt that the only thing to do was to keep observing the level of tipping and to patrol and enforce the system.

## ***Instruments***

### **Charging System**

The charging system was calculated 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.

The system is based upon a three part tariff. These 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. The annual cost for 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, the fee in 2002 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. It should be noted that these fees are lower today than in 2002 (€5.30 and €10.60 for 120L bins and 240L bins, respectively);
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. This fee remains the same today. However, a minimum number of emptying (7 for residual waste, 13 times for organic waste) are charged; and

3. A weight-based fee. This was set at €0.25/kg for residual waste and €0.15/kg for biowaste. These figures have actually declined over time and are €0.14 and €0.07 respectively.

The billing scheme works through an annual invoice, which calculates a bill based upon the previous year's performance by the household. 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 installments.

### Weighing system

The Garbage trucks are equipped with a calibrated dynamic weighing system that allows them to weigh the bins before and after emptying it. For 120 liter and 240 liter bins garbage weighing between 5 kg and 150 kg can be quantified.

The waste bins are equipped with a "*read-write chip*" or transponder, which operates without contact. A transmitter on the refuse vehicle stimulates the transponder to send out its barrel number. This registers the vehicle computer and adds weight. The data is stored in addition to security on the chip and transmitted to the removal to the District Office.



### Timeframe

In 1997, a trial across a community of 3000 persons was carried out.

In 1998, decision to introduce the scheme across 29 component communities, information and publicity campaigns were undertaken. In each community, a 13 week programme was implemented.

In 2000, within fourteen months of the decision being made (1998) the scheme was being rolled out across the whole county.

## 4 .Resources

---

Not available

## 5. Evaluation

---

### Results

#### - Avoided waste quantities (or toxicity)

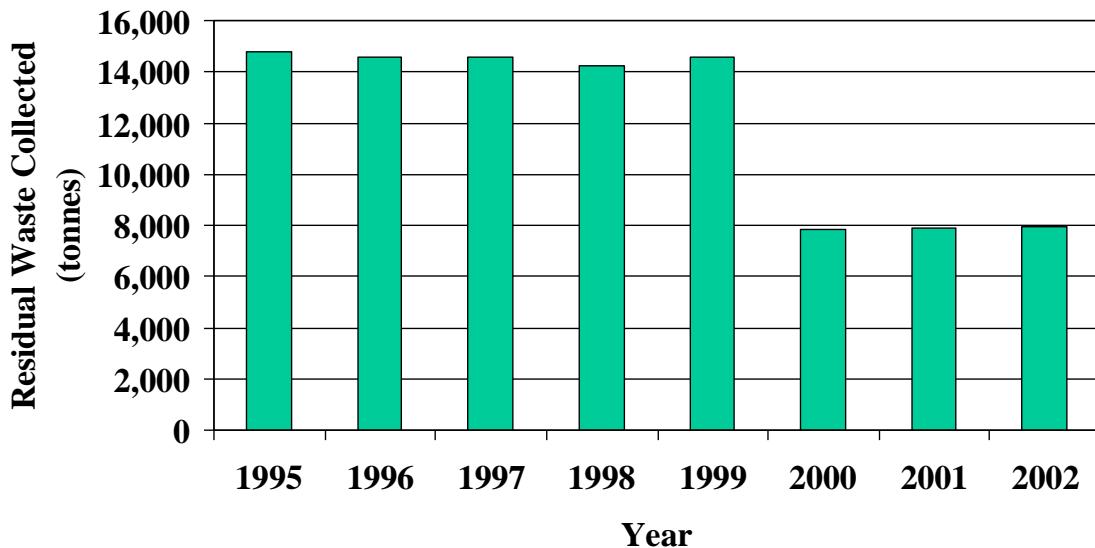
Under the scheme, though collections are only fortnightly, for several bin types, the set out rate fell close to 50%. In other words, on average, for many householders, bins are being set out approximately once a month. Interestingly, the set out rate tends to be lower for those using smaller bins. For 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, was changed such that the vehicles operate with a driver only.

### Residual Waste

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.

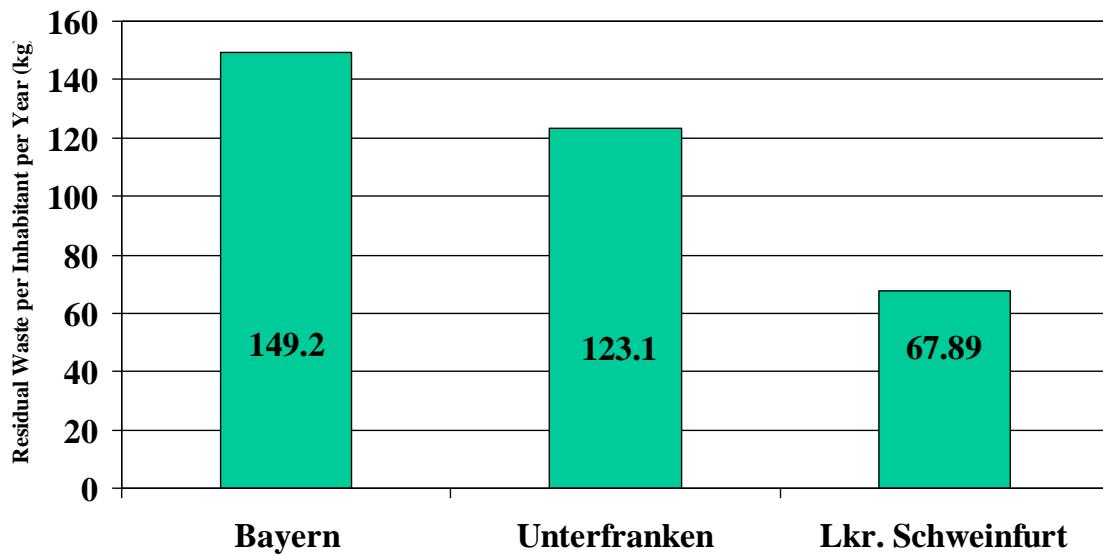
Figure 1 shows the effect of the schemes on the quantities of material collected at the doorstep. The effect is clearly dramatic, with collections falling by more than 40% of the original quantity. Figure 2 clearly shows that this is an exceptional result, even when compared with well-functioning schemes elsewhere in Germany.

Figure 1: Quantities of Residual Waste Collected Through Doorstep Collections



Source: Landratsamt Schweinfurt

Figure 2: Comparison of Residual Waste Collected at Doorstep, Landkreis Schweinfurt & Others



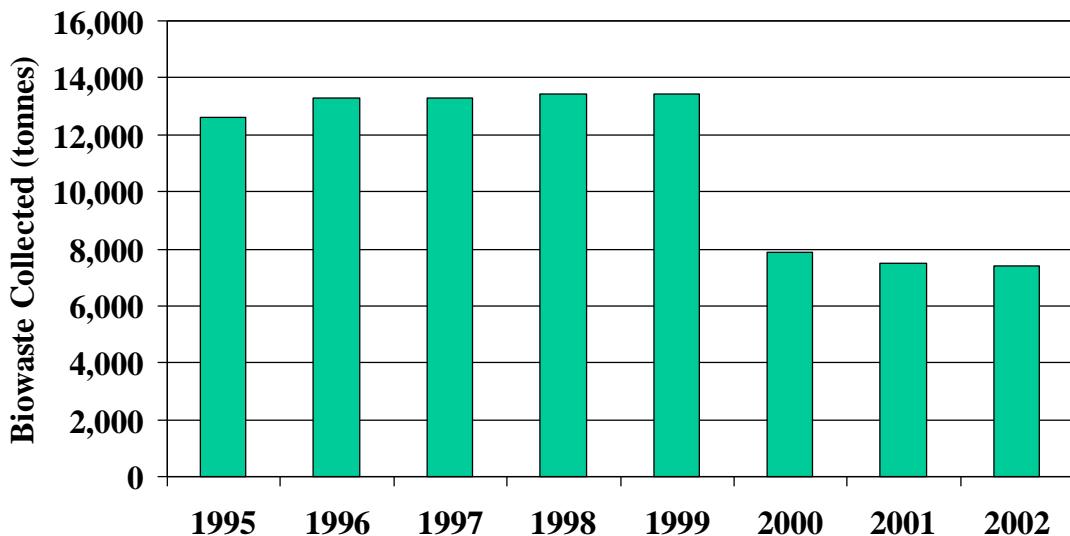
Source: Landratsamt Schweinfurt

### Separately Collected Biowaste

It might be expected that the decline in residual waste quantities would be explained through an increase in source separation. However, the quantity of material collected on the door-to-door biowaste collection also fell by more than 40%. In absolute terms, the fall was about 5,500 tonnes.

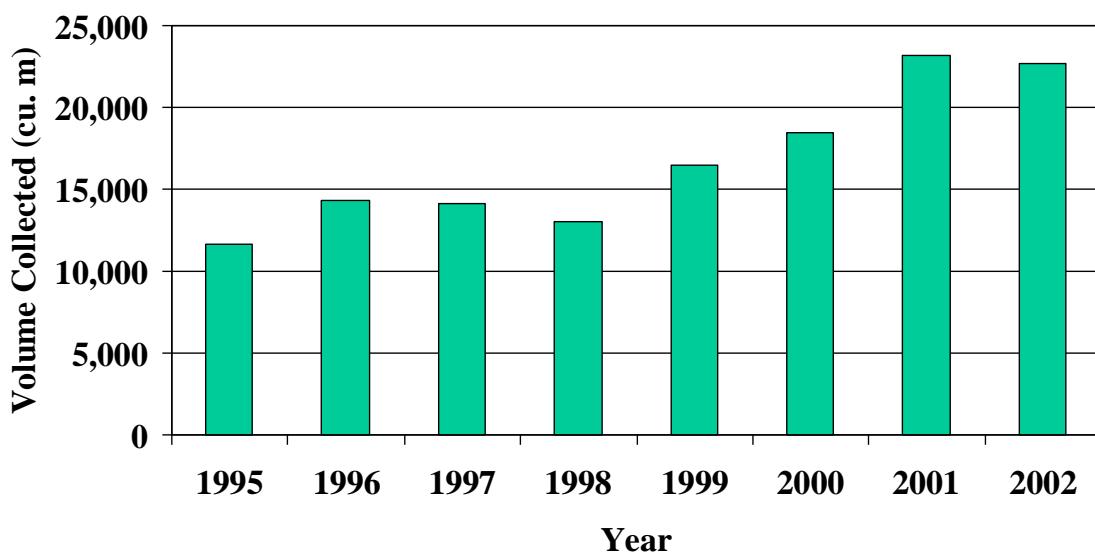
Part of the biowaste fraction simply moved into a different collection outlet. The County operates a network of sites where citizens can bring material from the garden for chipping. There was an increase of around 2,800 tonnes of this material (estimated on the basis of a volume of approximately 7,000 m<sup>3</sup> when shredded). Hence, this does not completely explain the reduction in biowaste collections, which suggests an increase in home composting. A net reduction of around 2,700 tonnes (23kg per inhabitant) of biowaste still remains.

Figure 3: Biowaste Collections, Door to Door System



Source: Landratsamt Schweinfurt

Figure 4: Change in Material Received at Chipping Stations (volume)

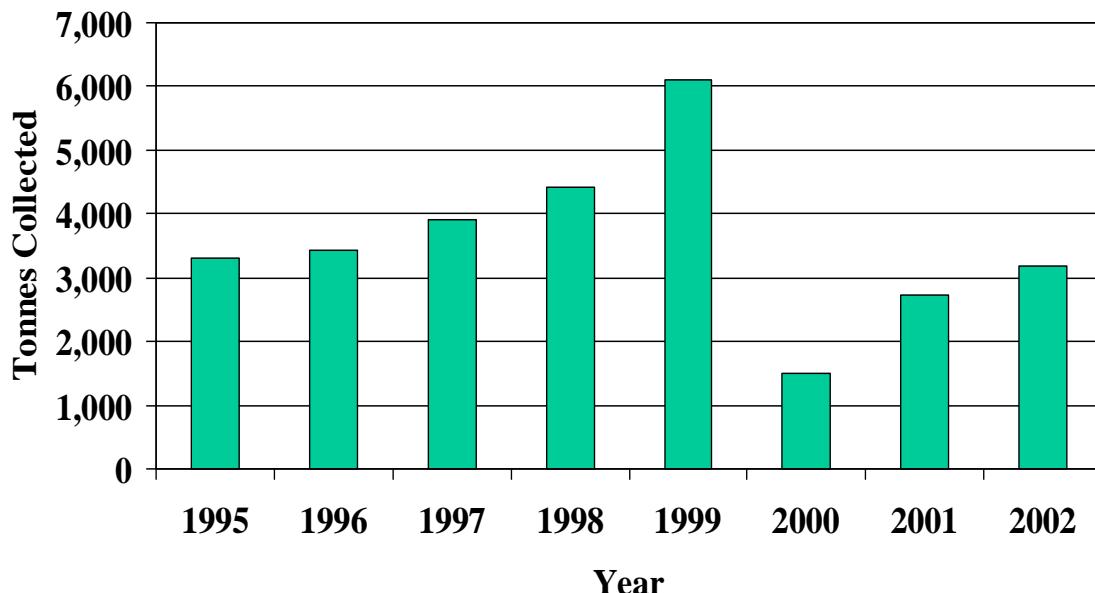


Source: Landratsamt Schweinfurt

### Bulky Waste Collections

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. This suggests that many households had a clear out prior to the scheme's introduction.

Figure 5: Bulky Waste Collections in Schweinfurt

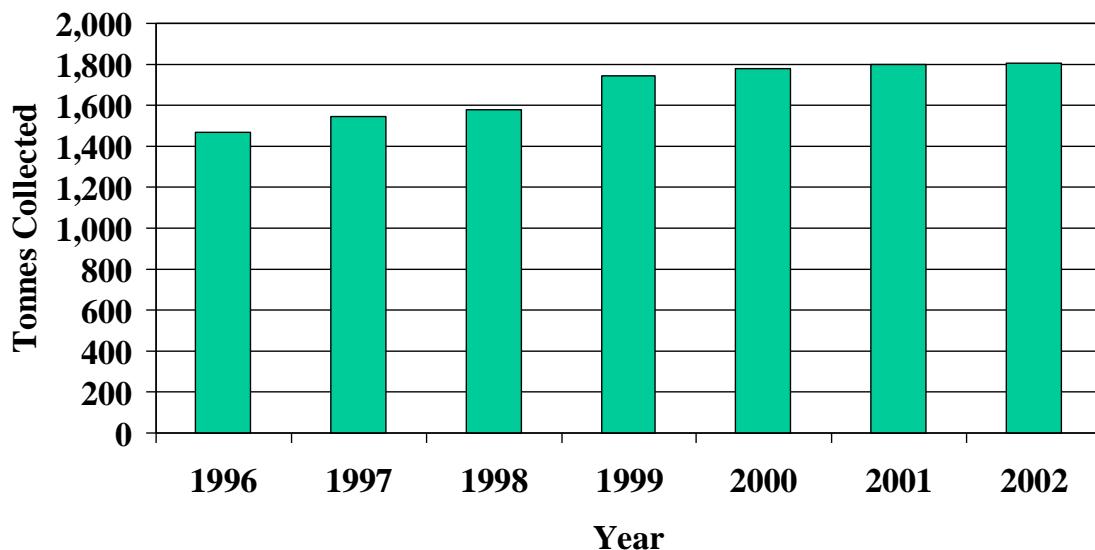


Source: Landratsamt Schweinfurt

#### Separate Collections (Bring Schemes)

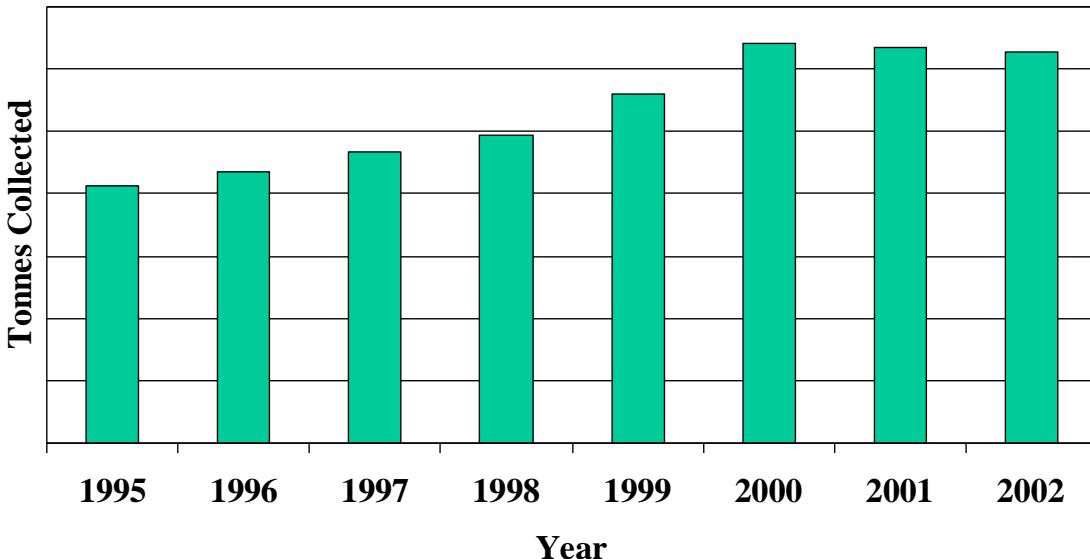
The county operates a network of 160 mini-recycling centres (bring sites) at which, typically, glass (colour separated), cans and plastics, paper and card, and textiles are collected. Paper collected separately by non-government organisations and through the bring sites increased by 400 tonnes (see Figure 6 and Figure 7).

Figure 6: Paper Collections through NGO Activities



Source: Landratsamt Schweinfurt

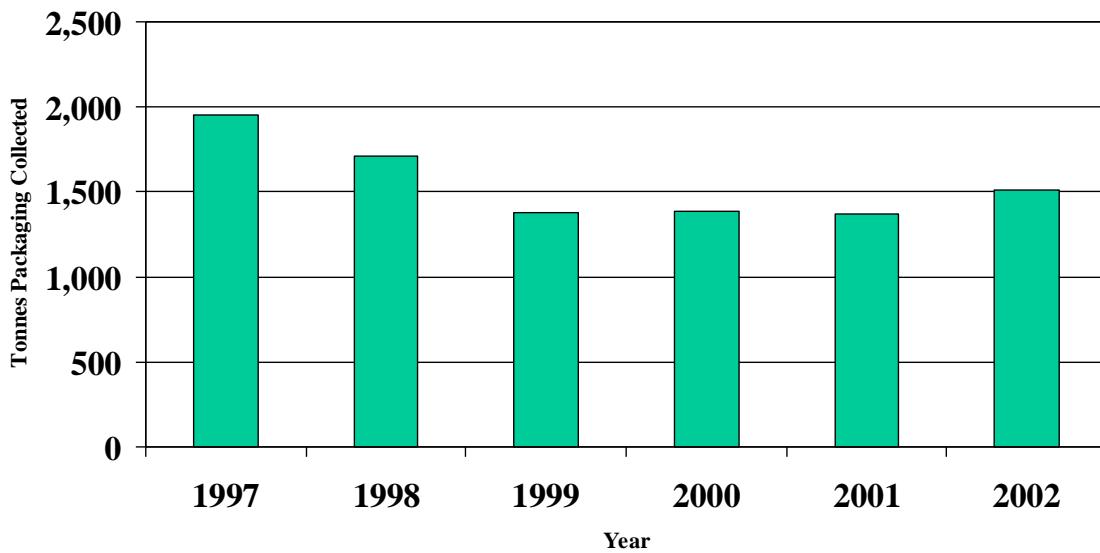
Figure 7: Paper Collection through Bring Schemes



Source: Landratsamt Schweinfurt

The amount of Packaging waste collected changed very little (see Figure 8), initially falling, though this is believed to be due in part to ongoing changes in the nature of packaging placed on the market.

Figure 8: Packaging Waste Collected (doorstep system)

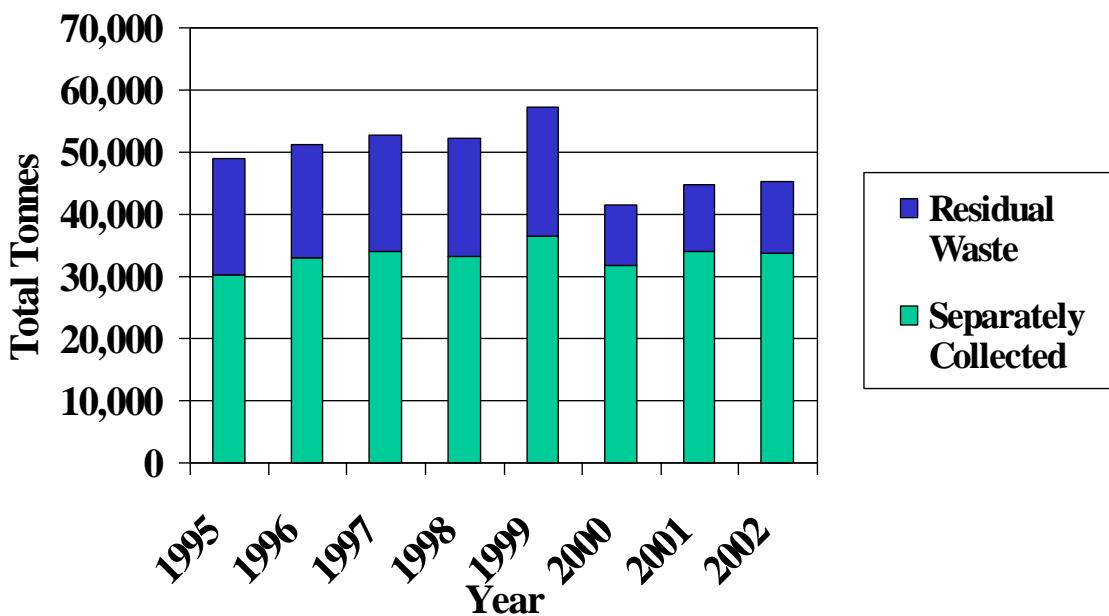


Source: Landratsamt Schweinfurt

### Net Effects

The net effect of these changes is shown in Figure 9. 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 9: Net Effect on Waste Management System



Source: Landratsamt Schweinfurt

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%. This is a truly outstanding performance by any comparator.

The most recent figures for Landkreis Schweinfurt indicate that this performance has been sustained over time (see Table 1). Residual waste has increased marginally from 92kg per inhabitant to 97kg per inhabitant. The recycling rate has increased slightly from 76% to 78%.

Table 1: Performance of Landkreis Schweinfurt, 2010

Waste Type	Quantity (kg/inh/yr)
Paper, cardboard	
Glass containers	26.31
Lightweight packaging	35.86
Scrap Metal	5.19
White goods	0.61
Biomass	63.97
Green Waste	96.24
Wood	22.50
	<b>339.49</b>
household waste including commercial waste	76.07
bulky waste	20.52
Problem waste from households	0.31
<b>TOTAL RESIDUAL</b>	<b>96.90</b>

Source: Abfallberatung Unterfranken

### - Other results - Explanation of the changes

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 implies a reduction of around 29% of the original residual waste fraction 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.

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.

The above line of thinking led the County to believe that it could readily explain around 35% of the drop in residual waste, but that the remaining reduction demanded closer examination. The County considered the possibilities for legitimate and illegitimate changes in behaviour which could explain the 'unexplained' reduction in residual waste.

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-uses. Statistics and compositional analysis suggested a reduction from 9.4kg/inhabitant before the scheme to 7kg/inhabitant after implementation; and
3. Consumer choices. Some evidence suggested that consumers were changing consumption habits to reduce the quantity of packaging and / or waste generated.

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 think this is an issue, and there is evidence to 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 this is considered a possibility, there was no evidence to suggest it was, or is, 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 made checks with water companies and there was no evidence to suggest a change in the nature or quantity of sewage; and
4. Fly-tipping could have taken place. There appear to be two critical places where fly-tipping occurs. One is at the mini recycling centres, the other is at litter bins. There was no evidence of disposal of waste in fields and forests and so forth. The evidence that the County gathered through its monitoring suggested that clearly fly-tipping happens, but the degree to which there has been a significant increase is not clear.

There has been an increase in the number of cases prosecuted. The attitude of the County was 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 is not possible to quantify the material cleaned up. On the one hand, there was no pre-scheme data, and on the other, once cleaned up, the waste sometimes enters the ‘formal’ system without data being separately recorded.

The upshot of the above discussion is that it is not 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.

## **Impacts**

### **- Avoided Costs for charging schemes in general**

Relatively few studies have explicitly sought to understand the environmental effects of PAYT schemes.

*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.*

*[...] 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.<sup>1</sup>*

The scheme in Schweinfurt gave rise to a reduction in costs of the order €6 per hhld. 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 Dual System Deutschland. 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.

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.

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 (see above). 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.

---

<sup>1</sup>Dijkgraaf and Gradus (2003) and (2004)

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 reuse, changes in consumption patterns, and, possibly, a move of commercial waste away from the municipal stream - are likely to have been important.

### ***Continuation over time***

Long term action since 1997

### ***Difficulties encountered***

#### **Shared waste bins lessen incentive**

Wherever there is joint use by several parties of the same refuse container - e.g. in apartment buildings or groups of neighbours choosing to share bins - the incentive for individual households to sort and reduce their waste is lower. Indeed, the benefits of individual efforts are distributed to all participants.

It would indeed be possible, with the consent of the owner, to remove large garbage containers and provide each apartment with separate bins for disposal, but this could quickly fail due to the required parking area and would in many cases lead to additional side costs. The calculation for the basic fee is simple: a 1100 liter waste container will cost € 49.03 monthly fee. Depending on bill-sharing procedures, the proportion of the fee shared by more than 9 households is lower than for individual bins (each € 5.30), provided that contribute the same share. In general, up to 20 or more parties use the same container, which lowers the fee per household.

Despite the reduced individual incentive, if all household agree to avoid waste and separate it properly, they jointly benefit from the system: lower basic fees linked to a large shared waste bin, low collection fee, and low weight fee. through good waste collection fees.

### ***Monitoring System***

The weighing and billing ensures accurate recording of waste quantities for different fractions and assessment of costs.

## 6. Lesson learnt & recommendations

---

### Opportunities & Challenges

This is a system whose performance is outstanding. An already high-performing system was made more so by the application of an intelligently designed PAYT charging scheme. The rigour with which the system was contemplated, prepared, implemented, and then monitored demonstrated a high level of commitment to the cause of pursuing a sustainable waste management strategy through appropriately incentivising households.

The use of the hybrid approach to charging is especially interesting. Weight-based systems, if not designed in this manner, might lead to high set out rates of bins with small quantities of waste. Here, the inclusion of both weight- and frequency-based charges acts to incentivise low set out rates of refuse bins, reducing the costs of the collection service.

Citizens have clearly responded to this incentive (so that savings in the quantity of residual waste set out for collection translate into genuine savings in the collection system). The study clearly points the way towards ‘tailor-made’ incentive schemes to achieve specific objectives.

### Key factors of success

Charging tends to work best where:

- The marginal benefit of avoided residual waste treatment / disposal is high. Charging systems will be more likely to ensure financial savings where the costs of landfilling / incineration are high, by which we mean, of the order €80 at least;
- Separate collection (of biowastes and recyclable materials) includes a wide range of materials, and is convenient (typically kerbside collected rather than through ‘bring’ systems) - this tends to limit the likelihood of illegal disposal / contamination of separately collected waste streams;
- Charge levels are set with a flat rate fixed fee supplemented by variable fees so as a) to ensure problems of revenue instability do not arise and b) to ensure variable rates are not so high they give rise to more compelling incentives to fly-tip;
- Charges are placed on residual waste taken to civic amenity sites as well as at the kerbside (so that waste does not simply move from one management route to another);
- Municipalities should be vigilant in the days shortly after the scheme’s introduction so as to make sure that fly-tipping and illegal disposal are clearly shown to be unacceptable; and
- Charges are levied - albeit at different rates - on all waste streams, including recycling - this fully integrated approach is likely to deliver the strongest incentive for waste prevention.

Political leadership - nationally (regarding national policy) and locally (in respect of local implementation) - is important. In some countries, national or regional policy sets a clear and structured agenda for local waste charging. The case of Landkreis Schweinfurt was one where the local political leader, recognising the potential for opposition to the proposed changes, made sure the system was first trialled in his own neighbourhood. At the other end of the

spectrum, despite significant investigation into the impact of charging for waste in the UK showing the benefits it would bring, this policy remains a political hot potato, with the coalition Government stripping away legislation which allowed local authorities to charge for waste.

Minimum standards for a quality, convenient collection service including a wide range of recyclables is desirable in order for charging systems to deliver the best outcomes. Eunomia described a charging scheme in Fingal, Ireland, where half of households had no kerbside recycling scheme available to them. The scheme led to many protests concerning the system. Another key point highlighted by Irish experience is that it is more difficult to operate DVR systems without problems where the waste collection system is a completely open market. The much more favourable circumstance - and the more common one in Europe - is to have all households 'linked to' the collection system, and with some of the costs of the service supported through (obligatory) local taxation.

## 7. Comparison with similar actions

---

Pay-as-you-throw (PAYT) schemes take a variety of forms:

- **Bin Volume-Based Schemes:** under these schemes, typically, households are asked at the beginning of a particular year to say which sized bin they would like to use. The charge is then related to the size of bin used. This type of scheme provides little by way of continuous, marginal incentive. It is generally seen as important to offer a good range of bin sizes (from smallest to largest), with a range of choice between the maximum and minimum size. An important decision in this type of system is whether, and if so, how often, to allow the choice of bin size to be changed. The costs of allowing frequent changes are obvious (in terms of the stock of bins and the need to make the replacement). These schemes are popular in the US, and have been popular in the past in Europe. It would seem that there has been some move away from this type of system in favour of other variants (see below) in some countries;
- **Frequency-Based Schemes:** these schemes are based upon the frequency of service provided to the household. Two possibilities exist:
  - The household subscribes for a particular service frequency (in which case, the marginal costs of waste generation are low); or
  - Either tags, or electronic chips, are used to record when bins are emptied following their being presented in a specific way.
- The electronic approach is increasingly common, and is widely used in the Netherlands and Belgium, as well as in part of Germany. The frequency-based aspect is important from the perspective of collection logistics, since the costs of collection are generally linked to the frequency of set-out (more than they are to weight). However, households may seek to reduce charges by ‘stomping’ (compacting) waste;
- **Volume and Frequency Based Schemes:** these schemes are usually based around the use of bins and as with the frequency-based schemes, they can be ‘subscription based’, or based upon the number of emptyings of the bin. In this case, as well as an incentive to reduce set-out frequencies, there is some incentive for reduction implied by the choice of bin size. However, the strength of the latter incentive is likely to be limited once the choice has been made;
- **Sack-based schemes:** sack-based schemes are also, essentially, volume based schemes. However, since the space available for refuse is not ‘fixed’, as with the volume-based bin schemes, there is a stronger incentive to reduce waste and recycle more. In these schemes, either a) specific (readily identifiable) sacks are sold to households, or b) tags / stickers are sold to households, which must be attached to the sacks. It is a good idea, generally, to offer different sack sizes for residents.
- **Weight-based schemes:** in these schemes, bins are usually equipped with a transponder which is read by software on the collection vehicle as the bin is loaded. The bin is weighed when it is loaded on the vehicle. Weight-based schemes have a good incentive effect for many materials, but the implications for waste collection logistics might not always be significantly affected by these schemes. Collection inefficiencies will be experienced where small quantities are collected on a frequent basis. However, where the marginal benefits of avoided disposal are significant, weight-based elements are clearly useful;

- **Bin volume, frequency and weight-based schemes:** schemes are becoming more sophisticated as technology develops. It is possible to have '3-D' schemes, with charges varying by bin size, set-out frequency and weight. In this way, there is an up-front choice to be made to reduce bin volume, an incentive to reduce set-out rates (so as to improve collection logistics) and a weight-based element to reflect the marginal benefits of avoided disposal. However, allowing the customer to choose the bin size and then regularly change this size is likely to incur additional costs. In frequency and weight-based schemes, the frequency based incentive works to optimise logistics, whilst the weight based incentive works to minimise set out of refuse (and biowaste in some schemes).

Evidently, the aim should be to develop a coherent system of charges to encourage the desired behavioural change, and to prevent those 'leakages' from one part of the system to another (on the basis of price differentials) which are not considered as desirable. The 'waste system' is like a balloon - squeeze it in one place and it tends to appear somewhere else.

### ***In different location/context***

There are a number of case studies which have been considered in the literature. Good examples can be found in:

- Bauer and Marie Lynn Miranda (1996) *The Urban Performance Of Unit Pricing: An Analysis Of Variable Rates For Residential Garbage Collection In Urban Areas*, Report prepared for Office of Policy, Planning and Evaluation, U.S. Environmental Protection Agency, Washington, D.C. 20460, April 1996;
- 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);
- Dijkgraaf, E., and Gradus, R. (2003) *Cost Savings of Unit-Based Pricing of Household waste, the case of the Netherlands*. Rotterdam: OCFEB;
- Ferrara, Ida, and Paul Missios (2005) *Recycling and Waste Diversion Effectiveness: Evidence from Canada*, *Environmental and Resource Economics* (2005) 30, pp.221-38;
- Hogg, D. (ed.) (2002) *Financing and Incentive Scheme for Municipal Waste Management: Case Studies*, Final Report to DG Environment the European Commission;
- Hogg, D. (2006) *Impact of Unit-based Waste Collection Charges* ENV/EPOC/WGWPR(2005)10/FINAL, Paris: OECD;
- Hong, S., Adams, M., and Love, S. (1993) *An economic analysis of household recycling of solid waste: the case of Portland, Oregon*. *Journal of Environmental Economics and Management*, 25, pp 136-146; and
- 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, 359-371.