DRAFT

HANDBOOK FOR

MANAGEMENT OF BIOWASTES

MANUAL FOR
SLOVAK MUNICIPALITIES AND
LOCAL AND REGIONAL AUTHORITIES

TWINNING LIGHT PROJECT

NO XXXXX

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GLOSSARY OF TERMS

The following are definitions of terms used in this report (in alphabetical order):

Agricultural Composting Plant (ACP) see Decentralised composting.

Biowaste: The term used in this report to describe source-separated household organic wastes (kitchen scraps, animal wastes, garden waste) which are to be collected from householders.

Costs: cost are expressed in € or in SKK; the exchange rate used is 1 € = 40 SKK.

Decentralised composting or **rural composting**: composting plants run by farmers in rural areas (hence the term also used, **Agricultural Composting Plant.**

Home composting: also **backyard composting**; the transformation into compost of food- and garden waste by families inside their gardens

Municipal Collection Centres: fenced and guarded structures where waste producers (families and some enterprises) can bring recyclable waste materials and garden-waste.

Municipal Solid Waste (MSW): Solid waste originating from a municipality, composed primarily of household waste.

Pay As You Through (PAYT): schemes that apply a variable waste fee for each waste producer related to the amount of waste produced (mainly by counting the number of emptyings of bins or bags assigned for residual waste)

1.0 INTRODUCTION

This Handbook has been prepared by the Team of Experts co-ordinated by Scuola Agraria del Parco di Monza with contributions, in particular, by

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in the context of the Phare Twinning Light Project named "Optimisation of handling of Biodegradable Waste" (Project Code: Slo_tlp 0128; Beneficiary: the Ministry of Environment of the Slovak Republic, Project Leader on behalf of the Beneficiary: Mrs. Marta Fratricova, Ministry of Environment).

The aim is to ***focus on*** the possible approaches in managing biowaste produced at Municipal level; hence by biowaste we mean all ***relevant materials defined in the EU waste catalog*** regarding "Municipal Waste" as stated in Commission decision n° 2000/532/EC and amended in n° 2001/118/EC. Biowastes are those materials described in Table 1.:

Table 1: Classes of Materials Falling Under the Definition of Biowaste

Description	Waste EU-code	Notes
Kitchen and canteen waste (foodwaste)	20 01 08	from households, restaurants, canteens, bars, coffee-shops, hospital and school canteens, etc.
Waste from public markets	20 03 02	only biodegradable materials equivalent to codes n°200108 and n°200201
Garden and park waste (yardwaste)	20 02 01	from private gardens and public parks and areas, etc.
Wood waste	20 01 38	not containing dangerous substances no furniture and bulky household-waste

Source: EU codes according to Commission Decision n° 2001/118/EC

Wastes arising from street cleaning (code 200303) and from septic tanks (code 200306) are explicitly excluded from the above definition and will not be considered in the Handbook.

However, besides the above materials, specific organic residues from the processing of agricultural products (agro-industries) may serve as a very valuable source of feedstocks for either composting or anaerobic digestion. A comprehensive list of further clean feedstock

materials is provided in the *"Recommendations for a Strategy for the Managament of Biowaste in the Slovak Republic"*

The Handbook continues with the following structure:

CHAPTER 2: LEGAL PRESCRIPTION FOR BIOWASTE COLLECTION AND RECOVERY

In this Chapter, we summarise the key drivers facing Municipalities, and Local Authorities (e.g. District and Regions) as far as management of biowaste, as part of the broader strategies for the management of waste and resources, is concerned. The elements and considerations are based on existing EU-regulation and legal framework.

CHAPTER 3: WASTE ANALYSIS

Here, we review the nature of waste which is handled by Slovak municipalities; the prominence of biodegradable wastes, such as as paper, cardboard, foodwaste and garden waste, is demonstrated.

CHAPTER 4: GENERAL WASTE MANAGEMENT OPTIONS FOR BIOWASTE

This chapter outlines the framework of options for municipalities and decision-makers in waste management regarding the different options for separate collection schemes for biowaste management. The different features of food waste and garden waste collections are shown.

CHAPTER 5: HOME COMPOSTING AS A MANAGEMENT OPTION

The large number of small settlements and rural areas in Slovakia suggests home-composting, which is the focus of this section (alongside practicable approaches for its promotion), should become a strategic tool in waste prevention and biowaste management.

CHAPTER 6: SCHEMES FOR SEPARATE COLLECTION OF FOODWASTE

The realisation of optimised collection scheme for the separate collection of food waste from households and activities (restaurants, canteens, etc) is shown, together with a list of suitable tools, vehicles and investment costs.

CHAPTER 7: ECONOMICS: EVALUATING COST FOR FOODWASTE AND RESIDUAL WASTE COLLECTION

This chapter shows how to evaluate the costs for collection schemes for food waste, integrated with a revised scheme for residual waste; cost analyses are based on wide experience gained in similar schemes across Europe, mostly planned and implemented by Authors themselves (which allows them to give a very robust forecast); costs need anyway to be tailored to the specific local conditions across Slovakia (e.g. as far as the cost of purchase and maintenance of vehicles is concerned); some adaptations have already been made, in particular assuming typical labour-costs of staff employed by private companies operating in the waste management sector in Slovakia.

CHAPTER 8: DECENTRALISED COMPOSTING

This chapter describes the approach to realising small composting sites in rural areas and in co-operation with local farmers associations; the technical requirements for agricultural composting plants, and also other types of composting facilities, are described in other Reports.[1]

CHAPTER 9: LIST OF CONTACTS

A list of contacts has been added in order to allow Municipalities to compare directly, getting deeper information if need be, with some of the best-practice cases, mentioned in the text.

The handbook was been conceived and written with a practical approach in mind, but at the same time leaving municipalities different options to choose from. Specific data regarding the amounts of waste that can be separately collected, the cost for collection tools, vehicles, etc., are referenced against current good practice cases in EU-countries.

The handbook can be copied and distributed free of charge to Municipalities, other Local Authorities and Institutions of the Slovak Republic; it may be copied and diffused, even partly, in other EU or non-EU Countries, upon explicit citation of the full document, its authors and the Twinning Light Project.

[1] Delivered to the Ministry of Environment – Waste Department in the context of the Twinning Light Project.

2.0 LEGAL PRESCRIPTION FOR BIOWASTE COLLECTION AND RECOVERY

Slovak municipalities face a variety of challenges in dealing with biodegradable wastes from households and other institutions from which they collect waste. These challenges also present opportunities in that they provide the motivation for the development of a more sustainable system of managing biodegradable materials. This more sustainable management process can generate a range of benefits as the management system shifts away from the traditional, unsustainable approach based around landfilling the majority of the waste collected.

There are now a variety of key drivers which are pushing waste management along a more sustainable path. These include measures at both the EU and the State-specific level. This Chapter describes these drivers and their implications for the management of biodegradable wastes by municipalities, Districts and Regions in Slovakia.

2.1 EU Regulations and Drivers

2.1.1 The EU Landfill Directive

This Directive[2] requires (amongst many other things) all EU Member States to reduce the amount of biodegradable municipal waste (BMW) sent to landfill to:

- 75% of that which was produced in 1995 by the year 2006;
- 50% of that which was produced in 1995 by the year 2009; and
- 35% of that which was produced in 1995 by the year 2016.

Slovakia is one of a number of EU Member States which, because of their heavy reliance on landfill, are able to take advantage of a four year derogation. This means that the target years become 2010, 2013 and 2020.

It is a quirk of the Directive that the term ‘municipal waste’ is not especially well-defined.

[2] Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste *Official Journal L 182 , 16/07/1999*

Municipal waste means:

- Waste from households, and
- Other waste that, because of its nature or composition, is similar to waste from households.

In Slovak legislation, the definition is given greater substance:

> *(14) Municipal waste shall mean household waste generated in a municipality by activities of individuals and waste of a similar nature generated by activities of legal entities or individuals – entrepreneurs, as well as waste generated by the activities of the municipality while cleaning public roads and areas administered by the same, and by the maintenance of public vegetation including parks and cemeteries.*

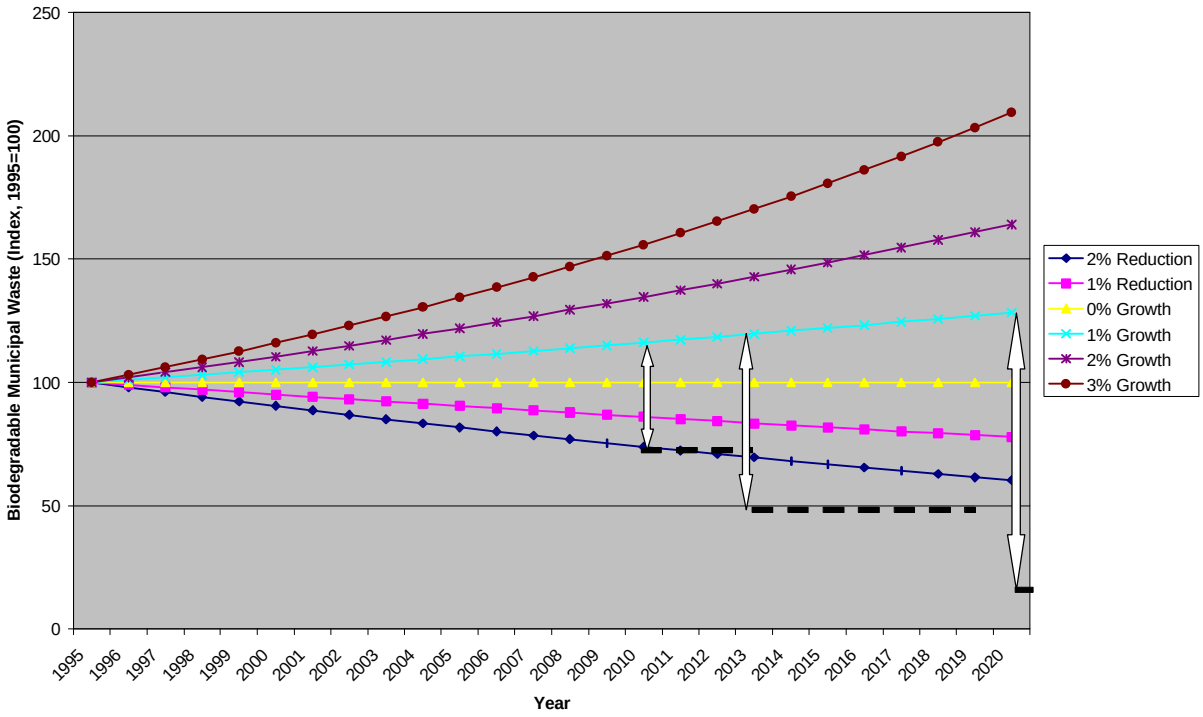
However the question remains as to what wastes are, or are not to be considered as 'similar' to those produced by activities of individuals. This is a question which has significance beyond Slovakia. It has special importance for those municipalities which (for one or other reason) collect large quantities of non-household waste.

2.1.1.1 Implications of the Directive

Generally, the Directive requires a progressive increase in the quantity of biodegradable municipal waste (BMW) to be diverted from landfill. This is shown graphically in Figure 1. The Arrows show the growing quantity of material which would have to be diverted under a scenario in which waste growth is 1% for all years to 2020. The diagram also shows that the requirement to divert waste from landfill is greater at higher rates of growth of BMW. This suggests a need to constrain the growth of BMW.

Clearly, although these targets apply at the national level, some means of tracking performance 'from the bottom up' will be required.

Figure 1: Requirements of the Landfill Directive



2.1.2 The Thematic Strategy on Soil Protection

The European Commission (EC) has recently launched a "Thematic Strategy on Soil Protection"[3], in which restoring organic matter is being regarded as a key tool to enhance agronomic and environmental functions of soils, such as:

- prevention of erosion and floods
- sequestration of carbon, thereby fighting climate change (which is also considered by the European Climate Change Programme as a suitable strategic approach towards fulfillment of European commitments as to reduction of Greenhouse Gases and related Climate Change)

[3] EC Communication "Towards a Thematic Strategy on Soil Protection" (COM(2002) 179, of 16.4.2002)

- reduced use of mineral fertilisers and pesticides, prevention of related pollution, etc.

This provides a powerful rationale to divert biowaste from disposal towards composting.

The EC Communication on the Soil Strategy has therefore focused on the potential pool of organic matter included in biowaste. An initiative on Biowaste is listed among "Actions" to be undertaken by the Communication, which reads:

> *"By the end of 2004 a directive on compost and other biowaste will be prepared with the aim to control potential contamination and to encourage the use of certified compost"*.

Arguably, the goal of "promoting the use", while concurrently "preventing contamination" may only be fulfilled through a wide implementation of strategies aiming at source separation of biowaste.

2.1.3 The EC Initiative on a EU Biowaste Directive

This initiative was already widely discussed among Member States and lately within the the EU strategy on Soil Protection. Two Working Documents and a discussion document about the merger of the Biowaste initiative into the Thematic Strategy on Soil Protection have been prepared and discussed among stakeholders and Member Sates during the years 1999-2004. The main issues raised were:

1. Encouragement of home and community composting schemes as an important tool of waste prevention;

2. Promotion of source separation of organic waste from households and specified industries as a key tool for the management of biowaste (following the principle that only a good quality feedstock material will guarantee a high quality compost);

3. Process standards in order to guarantee an effective reduction of potentially existing pathogenic organisms of epidemiological concern;

4. Quality requirements for the final compost (proposing a classification including high quality marketable compost products, lower grade composts, and stabilised biowaste for restricted applications); and

5. Following on from the quality classification, the eligible use of the different classes of outputs on land.

The most important issues for municipalities will relate to the first three of the above issues.

One of most important provisions included in previous Working Documents was the mandate for Member States to implement programmes for source separation of biowaste. This would be consistent with the mandate - set out in the EC Communication on the Soil Strategy - to prepare '*a directive (*...on compost and biowaste*…) with the aim to control potential contamination and to encourage the use of certified compost*'. The last Discussion Document, intended to provide for the basis for a broader discussion in the context of the Soil Strategy, again considers source separation as a '*key-point in a successful strategy for compost promotion'*. Accordingly, it stated:'*Compost should be considered a product only if it has been produced from separately collected biowaste'*.

The last Document does not go into details as to obligations on source separation, but the need to promote it is still regarded as a key element of the strategy, since the Document considers the need *'(…) to provide a "driver effect" for local authorities and the concerned industry'* through a comprehensive strategic approach (e.g. definition of targets or obligations).

Existing Slovak technical standards and legislation already addresses some key issues associated with these objectives (see Section 2.2.2 below).

2.1.4 The EU Animal By-products (ABP) Regulation

The Animal By-Products Regulation (EC 1774/2002) establishes different categories of material derived from animals, related to the risk of spreading serious diseases. This was the European response on several animal health crises (BSE, Foot and Mouth Disease, Classical Swine Fever, etc.).

Catering waste, (defined as '*all waste food originating in restaurants, catering facilities and kitchens, including central kitchens and household kitchens'*) is covered by the Regulation, which affects the treatment of food waste coming from source separation. Category 3, the 'lowest risk' category, includes Animal By-Products (ABPs) which were basically suitable for human consumption, or derived from processes which *"…are not affected by any signs of diseases communicable to humans or animals …"*.

All those Category 3 materials can be treated in composting or biogas plants, if certain standards for hygienisation (sanitisation), laid down in Annex VI of the Regulation, are applied.

Such requirements are relatively stringent, and are basically focused on the need to submit materials to a thermal inactivation at 70°C, for 1 hour, after being shredded to a 12 mm particle size. This poses particular challenges to design and proper management of compost sites, in particular as far as the need to shred materials to a relatively small particle size is concerned, since this is detrimental to proper management of the process (which requires at least part of the input material to be of greater particle size in order to provide "structure" to the mixture to be composted).

However, importantly, there is effectively and exemption from the requirements of Annex VI for all catering waste not coming *'from means of transport operating internationally'*. This material, rather than being subject to the requirements of Annex VI, can be transformed in a biogas plant or composted **in accordance with national law** pending the adoption harmonised European rules (Article 6(2)g of the Regulation). The implications of this legislation are that Slovakia is free to determine its own national processing standards for the treatment, in composting and biogas plants, of source separated food waste stemming from private households as well as restaurants.

At present, this is already covered by the Industrial Standard STN 46 5735, which is referenced by the Slovak Fertiliser Law, requiring a process temperature of 55 °C for at least 21 days during the initial heat producing phase of composting.

Further recommendations for the process management and final product control are being developed in agreement with the Ministry of Environment and other relevant Institutions in the context of the elaboration of various elements of the biowaste strategy.

2.2 Slovak Legislation and Drivers

The Slovak waste management legislation is adapting swiftly to the driving forces coming from the EU. A number of important measures are already in place regarding biowaste management in the country.

2.2.1 Act No. 17/2004 on Landfill Cost (substitutes # 327 of 1996)

This Act sets progressively increasing levies on landfilling for future years. The levy to be applied will depend upon the number of waste fractions being separated at source by the

municipality concerned. The levy is to be paid to the municipality in which the landfill is located. The levy rates proposed are set out in Table 2 below.

Table 2: Proposed Levies on Landfilling of MSW (SKK/tonne) in Slovakia

Current	Planned increase with:	2004	2005	2006	2007	2008
20	No source separation in place	30	50	100	200	300
	1 waste type source separated	27	45	90	180	270
	2	24	40	80	160	240
	3	21	35	70	140	210
	4	18	30	60	120	180
	5	15	25	50	100	150

NOTE: different tax levels apply for other materials such as inert waste, hazardous waste etc. A specific, higher tax (400 SKK in 2008) is also provided for "biodegradable waste".

These provisions are a relatively important driver to increase the number and type of schemes for source separation of various materials, and this arguably may also promote source separation of garden and food waste.

2.2.2 Act No. 24/2004

The above Act introduces two new obligations for Municipalities

- by 1st January 2006 green waste has to be source separated
- by 2010, Municipalities will have to run source separation for at least 5 items. This will have to include kitchen waste.

Those failing to comply will be subject to higher landfill fees pursuant to Act # 17 (see above). In addition, they may be fined.

Implicitly, this means that by 2010, *all* municipalities will have to run source separation schemes for biowaste (the law reads *'biological waste'*) and it seems clear that since garden waste is to be banned from disposal in 2006, the intention is to cover kitchen wastes under this proposal. For reasons to be made clear in Section 4 and 5, this may need some adaptations, since it may pose some problems to small villages, where intensive promotion of home

composting may be a more cost effective, and equally successful measure for diverting biowastes from landfilling. In such areas, the marginal benefit of source separation of food waste may be small relative to its cost, which, in sparsely populated areas, may be relatively high.

2.2.3 Approval Procedures

General approval requirements for waste recovery installations are covered by §§ 7 and 21 Act 223/2001 on Waste. This also includes minimum requirements for the application of technical and operating documents and record keeping.

In addition, there currently exists a national regulation (283/2001) providing general approval procedures, including technical and environmental performance requirements for waste recovery and disposal installations. This covers also composting and biogas plants.

The consent is administrated by the District authority for waste management. This means that all technical papers for the application have to be provided to the District authority.

However Waste Act No. 223/2001, as amended by Act No. 24/2004, states that small-scale composting plants, with an annual capacity of less than 10 tonnes, are to be exempted from the approval procedures.

2.2.4 Compost Standards

These are defined by the Industrial Standard STN 46 5735 (the standard was defined before the Slovak and Czech Republics split). There are 2 classes of material defined (see Table 3). Class 1 may be "REGISTERED" by UKSUP (the Central Control and Examination Institute of Agriculture). Once registered, it may be marketed according to the Law on Fertilisers. This implies no limit loads, and no requirement for licensing for its application, merely that the application takes place in line with good agronomic practice.

Class 2 cannot be registered, and hence cannot be marketed. It is not clear what applications are foreseen for this material. It used to be the case that Class II could be used in 'non-direct food' crops (pasturelands, fiber crops, etc.), with a maximum load of 20 t/ha in any 3 years. However, since it may not be 'registered', and it is not mentioned in the Law on Fertilisers, in practice, it cannot be used any more.

Table 3: Current Standards for Compost in Slovakia

	Compost Class 1 (mg/kg dm)	Compost Class 2 (mg/kg dm)		Compost Class 1 (mg/kg dm)	Compost Class 2 (mg/kg dm)
As	10	20	Ni	50	70
Cd	2	4	Pb	100	300
Cr	100	300	Zn	300	600
Cu	100	400	Mo	5	20
Hg	1	1,5			

2.3 Implications for Municipalities

Both the EU drivers and the existing Slovak drivers appear to be encouraging, to some extent, source separation of biowastes collected by municipalities. Hence, the subject of this Handbook acquires considerable significance. It attempts to assist municipalities in carrying out actions which are, increasingly, being encouraged by regulations at the EU and National level.

There are opportunities which arise in the context of these different drivers. They point towards more sustainable management of wastes, and a shift in perspective away from one in which waste is simply ‘disposed of’, and towards one which sees the materials in the waste stream as a source of useful products.

3.0 WASTE ANALYSIS

In all nations, the composition of municipal *solid* waste varies from place to place. In particular, it tends to vary with (amongst others):

- The nature of household type (proportion of households with flats, or with gardens, etc.);
- The socio-economic status of households (since this determines the propensity to purchase different goods);
- The nature of the collection service provided (since this affects the likelihood of finding different materials in the waste stream – here, the provision of collections of garden waste to households at zero marginal cost is especially important, as is the nature of the containment for residual waste);
- The degree to which home composting is heavily promoted (again affecting the quantity of garden waste in households); and
- The nature of fuels used in households (for example, if households use coal, one can expect high quantities of ash in winter months).

Composition of waste also varies with the seasons since some items are consumed in different quantities in winter and summer. This is especially true where measures are not taken to minimise the delivery of garden waste in areas where a high proportion of households have gardens.

3.1 Composition of Municipal Solid Waste in Slovakia

There is rather little by way of clear statistical data on the composition of municipal solid waste in Slovakia. This is not entirely surprising since such figures are always difficult to come by, and attempts to arrive at a nationally representative picture are not always meaningful given all the issues affecting composition at a local level. Some data appears in the *Waste Management Programme of the Slovak Republic* (see Table 4).

Table 4: Composition of Municipal Waste in 2000

Type of waste	Percentage [%]
Bio-degradable waste	38
Residue	30
Waste paper	13
Waste glass	8
Waste plastics	7
Hazardous components	1
Metals	3

Source: SLICPEN, cited in Waste Management Programme of the Slovak Republic

In other Accession States, estimates of composition are shown in Figure 2. Figures for other EU states are shown in Figure 3

Figure 2: Proportion of Different Waste Fractions in Municipal Solid Waste, Estonia, Hungary, Poland and Slovenia

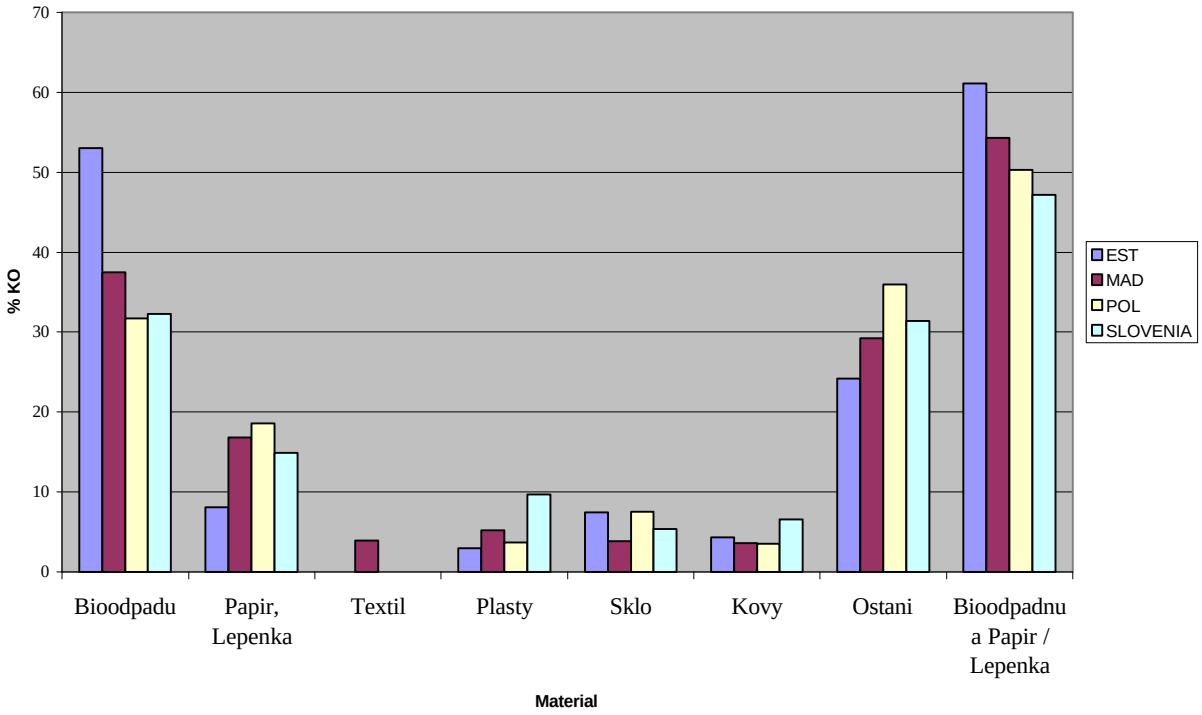
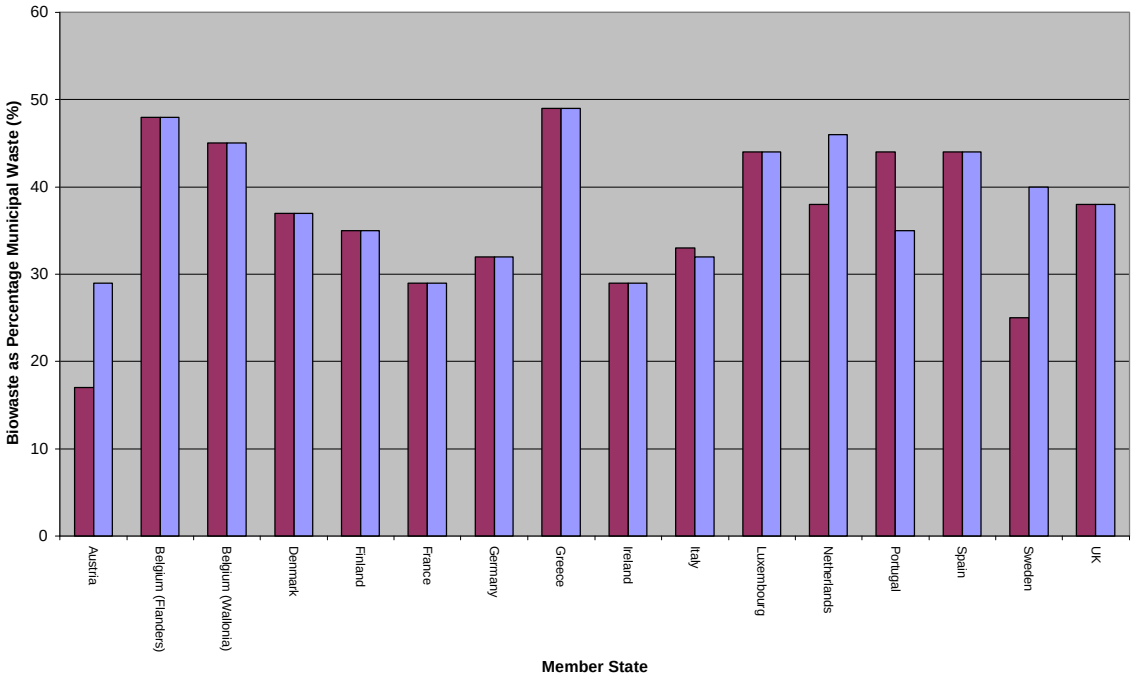


Figure 3: Proportion of Biowaste Fractions in Municipal Solid Waste, EU-15



Note: The two bars show two different sources. The Austrian figure is low because of high rates of home composting

3.2 Locally Relevant Data

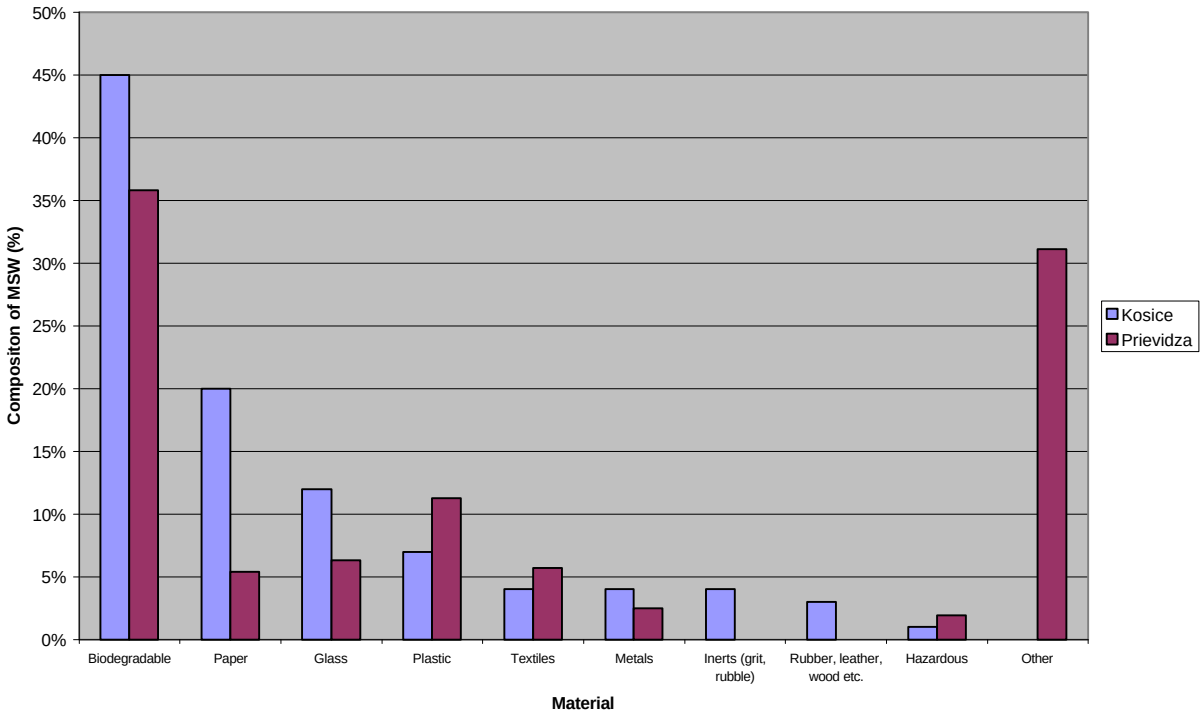
The foregoing is supported by the data we have been able to obtain at a local level in Slovak municipalities, coming from local initiatives on management of biowaste. In the first instance, two sets of analysis are shown. These are from Kosice and from Prievidza (see Figure 4).

In the second instance, we draw upon some of the information made available from East Slovakia. Waste was analysed from three municipalities in East Slovakia. These had different housing characteristics as shown in Table 5.

Table 5: Housing Structure in Cities Where Waste Analysis Took Place

	Prešov	**Humenné**	**Poprad**
Households in High Rise Building Areas	264	288	224
Inhabitants in High Rise Building Areas	793	839	857
Households in Detached Housing	50	52	56
Habitants in Detached Housing	159	152	224

Figure 4: Composition of MSW in Kosice and Prievidza

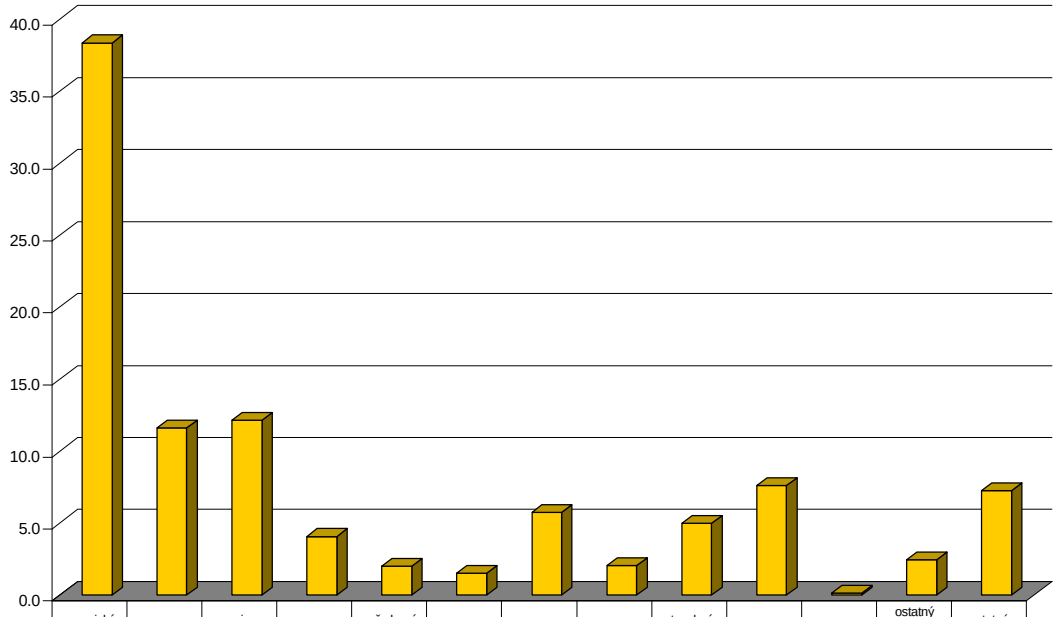


The results of the analysis show once again (see Figure 5) that the organic fraction (narrowly referred to as food and garden waste) of municipal solid waste is close to 40%, which is in line with the SLICPEN analysis. This result, the average for all the cities analysed, does, however, mask some important variation.

It can be seen that the variation is quite stark. Figure 6 shows the estimated composition of waste in each of the three separate cities. In particular, in the case of the biowaste fraction, one of the three cities has a far lower composition than the others (see Figure 6). This figure appears unusually low.

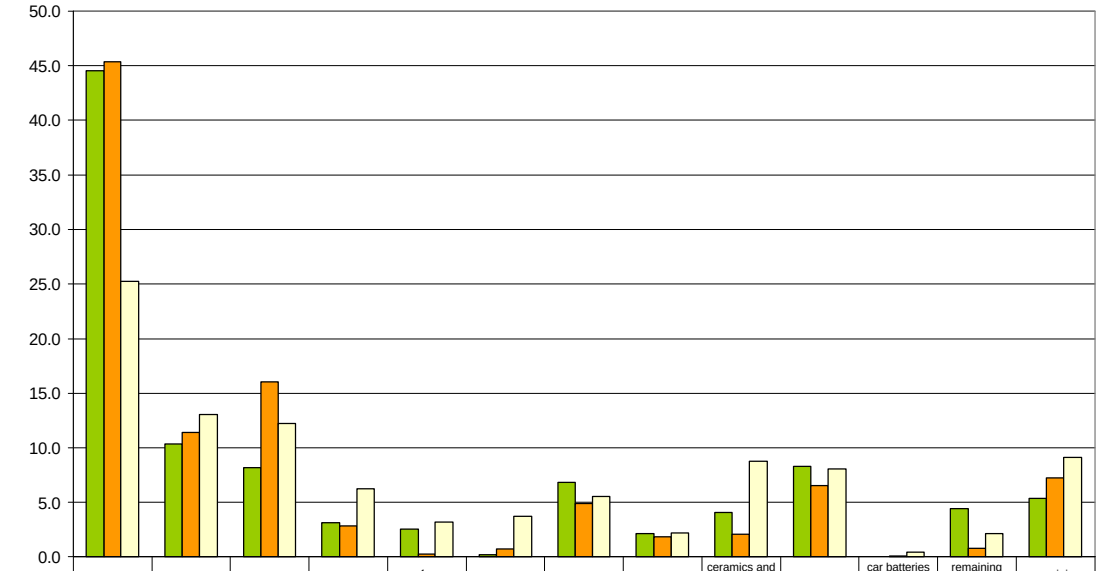
The other important issue is the seasonality (see Figure 7). The biowaste fraction shows the opposite pattern to that of 'other' waste.

Figure 5: Average Composition of Waste in East Slovakia Cities



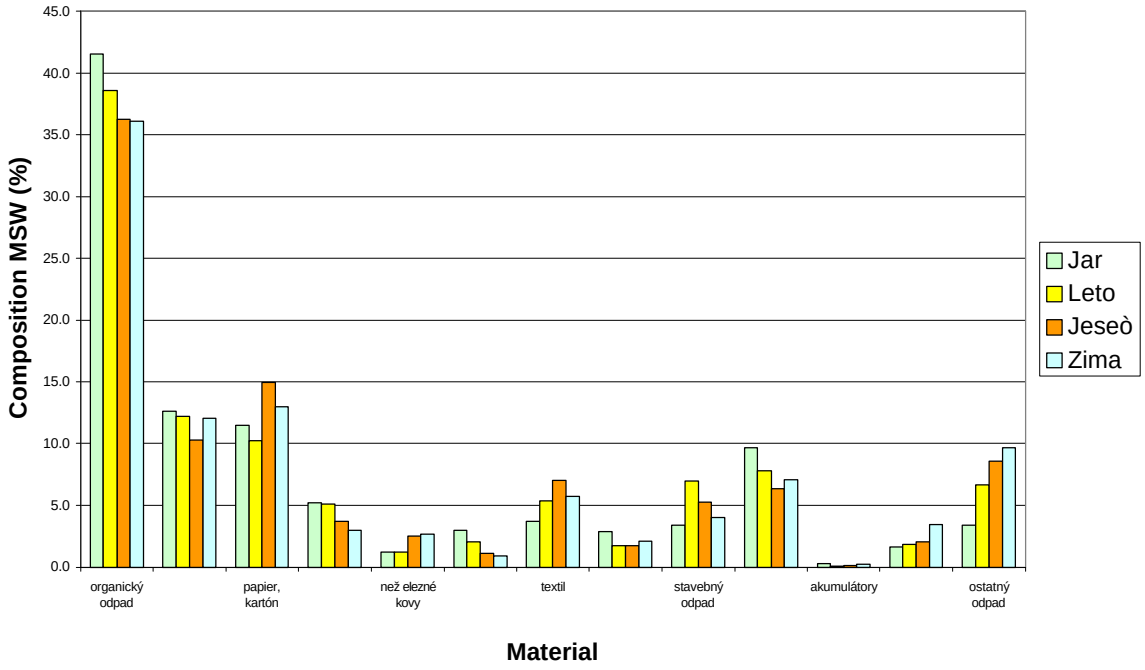
	organický odpad	plasty	papier, kartón	ž elezné kovy	než elezné kovy	guma	textil	drevo	stavebný odpad	sklo	akumulátory	ostatný nebezpeèný odpad	ostatný odpad
%	38.4	11.6	12.1	4.1	2.0	1.5	5.7	2.1	5.0	7.6	0.2	2.5	7.3

Figure 6: Composition of Waste in Each of the Three Cities Analysed



	organic waste	plastics	paper, cardboard	ferrous metal	non-ferrous metal	rubber	textile	wood	ceramics and construction waste	glass	car batteries and other acumulators	remaining hazardous waste	remaining waste
Prešov	44.5	10.4	8.2	3.1	2.6	0.2	6.8	2.1	4.1	8.3	0.0	4.4	5.4
Poprad	45.4	11.4	16.0	2.8	0.3	0.7	4.9	1.8	2.1	6.5	0.0	0.8	7.3
Humenné	25.2	13.1	12.2	6.3	3.2	3.7	5.5	2.2	8.8	8.0	0.5	2.2	9.1

Figure 7: Seasonal Variation in Composition in Waste Composition



3.3 Summary

Some key points flow from the above analysis:

1. For the purposes of the Landfill Directive, biodegradable municipal solid waste is of the greatest importance. The key fractions of biodegradable municipal waste include:
    a. Kitchen waste
    b. Garden waste
    c. Paper and card
    d. Textiles (of natural origin)
    e. Nappies;
    f. Wood.

2. In general, in other European countries, whether they be the ‘old’ EU-15, or other states in the new EU-25, waste composition analysis shows that the two fractions ‘kitchen waste’ and ‘garden waste’ (from here on, termed ‘biowaste’) account by themselves for between 30% and 40% of MSW. We would expect that in most cases in Slovakia, these two components account for close to 40% of MSW;

3. This is supported by the small amount of data we have from those Slovak municipalities which have carried out their own analysis of this nature;

4. In most situations, one finds that if one adds to the biowaste fraction all paper and card, one finds that these fractions account for between 50% and 65% of all MSW. Across countries, the relative proportions of biowaste, and of paper and card, vary, but the total remains in this range;

5. In most countries, the biodegradable fraction of MSW (also including textiles and nappies, besides “biowaste”, paper and paperboard) is around 65%-70%. In Slovakia, we would expect the figure to be within this range;

6. This implies that typically, the fractions ‘biowaste’ and ‘paper and card’ together account for around 80%-90% of all biodegradable municipal waste.

The clear inference of the above is that strategies to comply with the Landfill Directive should be focused heavily on two fractions of the waste stream, paper and card, and biowaste. Of the two, the later is typically the larger fraction by weight. It is also the more problematic when landfilled, and the least likely to have any energetic value in energy-from-waste facilities (because in well-managed systems, much of the material will be kitchen wastes, and the high moisture context of such wastes mitigates against high levels of energy recovery).

4.0 GENERAL WASTE MANAGEMENT OPTIONS FOR BIOWASTE

4.1 Qualitative listing of organic waste suitable for high-quality compost production

The different materials that can be regarded as biowaste are listed in Chapter 1.0 with reference to the EU waste-codes. A qualitative list of what belongs to the two ***main categories*** described in this text is useful.

We consider:

- **Foodwaste:** the mixture of both cooked and raw materials left over after the preparation and consumption of human food; the origin can be either private (households), or from restaurants, canteens, bars, etc.
- **Garden waste**: the mixture of waste coming from private gardens (i.e families) or from public areas such as parks, playgrounds, etc.
- **Other organic waste from agro-industries:** waste from food and animal feed processing or the processing of agricultural products for other purposes.

A non exhaustive list of examples is given in Table 6. A comprehensive list of possible feedstock's will be delivered in the report: “Proposal for regulations on restrictions for landfilling and management of biowaste”

Table 6: Suitable Materials for Composting

Foodwaste	Garden waste	Other organic waste from agro-industries
➢ Residues from vegetables for preparing and consuming food (salad, tomatoes, beans, etc) ➢ Fruit peelings and residues (orange, apple, bananas, etc) ➢ Cooked stuff (potatoes, rice, pasta, soups, etc) ➢ Meat and Fish ➢ Egg-shells ➢ Tea bags, coffee filters residue, etc.	➢ Green cuttings (grass) ➢ Pruning and clipping residues ➢ Leaves ➢ Wood (untreated !, furniture is excluded) ➢ Dead plants residues ➢ Flower residues	➢ Residues of food & fodder processing including extraction, pressing, filtering etc. ➢ Perished seed ➢ Residues from animal horn, hair, feather and wool ➢ Paunch waste ➢ Brewery and distillery residues ➢ Cacao shells

4.2 Effective Biowaste Collection

Separate collection of biowaste represents a strategic choice in order to reach high recycling targets and to reduce the amount of biowaste to be disposed.[4] Some general aspects have to be considered in order to plan effective collection schemes for source separation of biowaste:

1	The different characteristics of foodwaste (including also cooked stuff) and garden waste (from private houses and public areas)
2	A system that targets both garden and kitchen waste with equal intensity is likely to become a system where a huge delivery of garden waste is to be expected.
3	A system, that doesn't prevent high delivery of garden waste into the collection system is likely to increase the overall amount of waste to be managed by the public authority, increasing the management cost for that material. It will also act as a disincentive for home composting (if the collection of garden waste is offered free of charge);
4	A collection scheme for biowaste that is not able to intercept sufficiently foodwaste, will not be as effective in reducing the amount of biowaste material in residual waste, and hence the amount of biowaste for landfilling and disposal

[4] as stated in the EU Landfill Directive – see Section 2.1.1

Where garden waste is collected together with kitchen waste (in a single bin as for instance in early Central European schemes), it is not unusual to see collection rates – at least in settlements with single houses and gardens – as high as 150-200 kg $inh^{-1}year^{-1}$ and more. We have to underline that such a situation makes recycling rates higher, but it also *increases the overall quantity of waste to be collected and treated.* Sometimes collection at the doorstep for garden waste reaches 300-400 kg $inh^{-1}year^{-1}$ garden waste collected, but at the same time, it leads to a worryingly high figure of around 800 kg $inh^{-1}year^{-1}$ for total waste arisings.

We believe that rather than collecting biowastes which can be treated at home through home composting, effort has to be made to find suitable systems that enable high recycling rates, without causing an increase in the overall MSW collected. Best practice cases in EU- countries are effective in this regard if the collection scheme for compostables keeps the **collection of food waste and that of garden waste separated**. One scheme has to tackle only food waste as a whole (including cooked foods such as meat and fish), by means of small volume bins and buckets, whereas a different scheme tackles garden waste only.

A specific collection of garden waste enables waste managers to plan and run a system:

- which does not involve seasonal fluctuations for the collection of food waste;
- which is kept separated from the specific collection systems for food waste. Food wastes are fermentable, wet and have much higher bulk density, thus requiring tools and systems specifically suited to them;
- with relatively low collection and treatment costs for the garden waste itself, thanks to simplified collection and lower processing fees applied by composting plants; and
- which makes it possible to enhance home composting. As long as households are not provided with a large-volume bin, they are less likely to deliver their yard waste to the collection service, so they are more likely to try, or to continue, backyard composting.

Obviously collection frequencies for residual waste can be reduced only when an effective separation of foodstuffs (which are the most odorous part of waste), yielding high captures, is in

place. Table 7 shows that doorstep schemes enable much higher performances. Large road containers yield much lower quantities - actually their capture is sometimes similar, *but a high percentage of yard waste contributes, and real capture of food waste is low.* Such hints have to be kept in mind above all *whenever planning a scheme in those situations where a high percentage of detached houses with gardens can be found.*

Table 7: Specific Results of Biowaste separatly collected with road containers and door to door schemes – quantities and purity

Collection scheme	Interception of foodwaste (g/inhab. day)	Presence of yard waste inside collection tools (g/inhab. day)	Purity (w/w)
Door to door	160-250	0% (if delivery banned) to 10 % (low available volumes)	97–99.5%
Road container	60 - 120	40-70% (seasonal)	85–96.5 %

Source: Surveys on waste composition and analysis by Scuola Agraria del Parco di Monza – Italy

The effective collection of foodwaste makes it possible to collect residual waste less frequently with fewer problems. Analytical measurements - where a door-to-door collection is adopted - report the content of food stuffs inside residual waste at an average of 15 % and sometimes lower, which is much lower than in previous source separation programmes adopted in 'Central Europe' (i.e. the low countries, Germany and Austria). Cutting down collection frequencies for residual waste constitutes in itself *one of the most important tools to optimise schemes (especially in terms of costs, and material captures) for source segregation of food waste.*

4.3 Distinctive Features of Food Waste and Garden Waste

4.3.1 The Troublesome Features of Food Scraps

Foodwaste is highly putrescible and has a high moisture content. This requires the adoption of specific tools, systems and collection frequencies in order to ensure the system is clean, convenient and user-friendly. Once citizens feel comfortable with a system, the overall participation is enhanced. This leads to better quality, a higher capture of targeted material, and a reduction in the percentage of food stuffs inside residual waste.

4.3.2 Biochemical and Seasonal Features

Where a doorstep collection for food waste is adopted, the collection of garden waste can be carried out in a different way to that adopted for food waste. This in turn makes possible an overall optimisation of the scheme, as intensive features of the collection of food waste (the need to collect at high frequencies due to odour issues, and the need to use watertight bags to contain material) need not apply to garden waste. Garden waste does not require such intensive collection patterns (it does not smell, it does not attract flies and rodents in the same way, and it does not lead to rapid production of leachate – indeed, most of that which does can be readily treated in the garden either through 'grass-cycling' or home composting).

4.3.3 Bulk Densities

The low bulk density of garden waste, characteristic of the material's structure, suggests the use of compacting vehicles for collecting garden waste. In the case of food waste, the high moisture content, and higher bulk density, enables the use of much simpler bulk lorries that are much cheaper at an equivalent working capacity (there is no need for a compaction mechanism). This is one of the most powerful tools to optimise the operational features and costs related to systems for source separation of compostable waste.

Table 8: Basic features of Food Waste and Garden Waste

Biowaste	Density (kg/l)	Moisture (% w/w)	Compaction during collection
Food-waste	0.50 – 0.70	80 – 90	No
Garden-waste (not shredded)	0.15 – 0.25	40 – 80 *	Yes

*Note: * high values mainly for grass-cutting.*

4.4 Home-composting and Decentralised Composting as a Tool for Biowaste Management

2,417 municipalities in Slovak republic have less than 1,000 inhabitants, representing about 70% of all municipalities; only 53 municipalities have a population above 20,000 inhabitants. Table 9 shows some significant numbers.

As to sparsely populated settlements (rural areas) and small municipalities (those with less than 1000-1500 inhab), these have two main strategies to build up effective scheme for biowaste management:

1. food- and gardenwaste should not be source separated because, on the one hand, an intensive scheme would be too costly, and on the other hand, in such situations, promotion of home composting proves to be much more effective, and this reduces the need to target food waste

2. instigate collection schemes for foodwaste only, in cooperation with other municipalities (i.e District collection), in order to optimize collection routes and investment costs (for vehicles, etc) and manage gardenwaste by means of home-composting.

Table 9: Slovak municipalities classified by n° of inhabitants

Inhabitant class	N° municipalities	% municipalities
<200	366	13%
201-500	807	29%
501-1000	790	28%
1001-2000	454	16%
2001-3000	154	5%
3001-5000	106	4%
5001-10000	54	2%
10001-20000	34	1%
20001-30000	25	1%
30001-50000	17	1%
50001-80000	6	0%
> 80001	5	0%

Source: Brano Monok – elaboration of data from Slovak Statistic Office

A very interesting approach in rural areas - suitable even in some larger municipalities with mainly semi-detached and detached households - ***combines*** the adoption and promotion ***of home-composting*** in areas with detached households ***and*** a ***separate collection of foodwaste*** only at high-rise buildings. The latter activity is often performed in co-operation with local farmers, in a strategy named **Decentralised composting**, that aims farmers to perform:

1. the separate collection of foodwaste and

2. the composting of source separated kitchen and garden directly on the farms, where compost as a product can be re-used directly

So in ACP (agricultural composting plants) compost is produced and made available at the farms, so it can be used directly by farmers involved in the strategy.

The next figure shows the main role of home-composting and decentralized biowaste management in rural areas. Home composting will be described in detail in Chapter 5.0, while a decentralized composting strategy is outlined in Chapter 8.0.

Table 10: Main principles of the hierarchy of decentralized biowaste management, including ACP as a key-element

As much individual composting as possible (home composting)	Separate collection only complimentary	Favouring agricultural composting
✓ No transport ✓ Sustainable garden management ✓ Visualization of a natural "recycling" process ✓ Low costs for the waste management system (only public relations) ✓ No costs for citizens	✓ high rise buildings ✓ for those who don't want ✓ recycling is guaranteed ✓ biowaste is processed at composting plants ✓ no biowaste in residual waste	✓ Proximity principle ✓ High level of quality commitment by farmers ✓ Application of compost in as soil improver in agriculture ✓Substitution of fertilizers ✓ Additional income for farmers ✓ Visible for the inhabitants → high transparency → high identification

4.5 Collection Schemes for Garden Waste

4.5.1 Potential Production of Gardenwaste

In normal weather and cropping conditions, lawn mowings from public and private areas can yield 2 to 6 kg year^{-1} of grass clippings per square meter. These figures can be roughly doubled when one takes into account prunings from trees and bushes, and leaves.

4.5.2 Problems of Intensive Collection Schemes and Unmanaged Bring Sites for Garden Waste

Garden waste collections tend to be 'additional' collections. In terms of their effectiveness in diverting biowaste from landfill, the effect is limited entirely to the effect on garden waste which might otherwise have found itself into refuse. Other things being equal, this effect would be expected to be greatest in situations where there was (prior to the garden waste collection

being implemented) less constraint on the delivery of garden waste into refuse. But even in such situations, an increase in collected quantities is to be expected.

The delivery of garden waste is stimulated by the convenience of its collection. This may have the following consequences which, though generally 'negative', can be addressed:

- A high delivery of garden waste into the collection system;
- A high level of seasonality in the collected waste;
- A disincentive to home-composting (if the collection is free); and
- An increase in costs resulting from the high delivery of material;
- The general outcome is a high recycling rate, but the overall MSW arising figures are much higher as well (an additional weight of more than 100kg per inhabitant may be expected). Hence an increase in costs resulting from the high delivery of material is to be expected.

On the other hand, the case of bring schemes based on unguarded road containers (between 1000 – 5000 l), have the undesired effect of collecting large amounts of gardenwaste, contaminated with other waste-streams as:

- Bulky waste
- Old furniture and household appliance (TV, refrigerqator, etc.)
- Hazardous waste (glues, colour, etc)
- Demolition and construction residues

Uncontrolled container collection results in substandard feedstock quality, and hence, the collected materials are more likely to be disposed than recycled as compost.

4.5.3 Effective Management Priorities

In an attempt to address previous mentioned undesirable effects of intensive door-to-door collections and uncontrolled bring schemes by means of road containers, to realise an **effective scheme for garden-waste** management *priority should be given to*:

1	**Promotion and enhancement of home-composting:** as long as households are not provided with free garden wate collections, they can be encouraged to try backyard composting, or *to maintain such behaviour in those many places where such composting is already widely practiced*. This maintains a good balance between the delivery of yard waste to the service and the participation to programs for home composting.
2	**Bring schemes**, collecting garden-waste **at municipal collection centres** (MCC), representing a relatively low-cost collection system for municipalities, even if the recycling (composting) will represent an additional cost. The average capture of garden waste collected where systems are well established through specific collection routes, mainly adopting bring schemes at MCC, is often 30-70 kg inh^{-1} $year^{-1}$.
3	**Collection at the door-step**; in order to help people who find it troublesome to go to MCC (for instance due to lack of space in their car, or whatever the problem) a collection at the doorstep can be run, with a specific round ('green circuit'). It is advisable to do this only in specific seasons and with a much lower frequency of collection than that of kitchen waste. (i.e. monthly or less).

Regarding option 3 above, it should be stressed that garden waste collection at the doorstep should be on demand only, hence applying PAYT. This can effectively be managed by applying charges for emptying the bins provided for collection or by selling biodegradable bags (i.e. paper or modified starch , etc) to the households, into which the garden waste must be provided at the kerbside. This means that the costs of the collection service can be covered.

A fourth waste flow which should be considered, even if of non-domestic origin, is the case of **individual collection or delivery contracts with companies which process products from agriculture or forestry.** The acceptance and treatment of these organic materials together with municipal waste should be done **only if** it is allowed and defined by specific National obligatory standards. Deliveries are charged on by treatment fees.

Table 11: Specific Results of Gardenwaste collected with different collection schemes – quantities and purity

Collection scheme	**Intensive collection (door to door)**	**Bring scheme Road container (un-garded)**	**Bring scheme at Municipal Sites (& home-composting)**	**Home composting**
Interception of gardenwaste (kg/inhab. y)	70 - 160	20 – 70	30 - 70	-
Purity (w/w)	Good	Poor	Very Good	Very Good

A general rule for municipalities should be that *where there are lawn cuttings, there is a garden in which home composting could be performed*. The purpose should then be to adopt a collection system which does not make it too easy for households to deliver their garden waste. This is why it makes sense to keep the collection of garden waste separate from the collection of kitchen waste.

4.6 Summary

Regarding the different strategies outlined in Chapter 4, we can summarise the approaches for 3 general situations.

Municipalities willing to realise optimised collection schemes for foodwaste, and at the same time preventing excessive deliveries (and cost) for garden waste management. Detailed information about the effective realisation of separate collection schemes for foodwaste is given in chapter 6.0, together with specific information about investment and collection cost (chapter 7.0). Home composting is in any case the basic instrument for managing garden waste; it might be also collected at the doorstep, but only by charging for that service. This can effectively be managed by selling paper bags by the municipalities to the households, in which the garden waste must be provided at the kerbside on demand.

	Separate collection scheme	Home composting	Municipal collection centre
Foodwaste	yes (door to door)		
Gardenwaste	(on demand only)	yes	yes
Residual waste	yes (door to door)		

The second situation applies for small municipalities, with a large presence of semi-detached houses or suburbs with a rural structure; in this case home-composting should be used as a tool for both food and garden waste management in those areas with detached and semidetached settlings. Families living in apartments and flats (high-rise buildings) should be served by a specific collection for foodwaste. Garden waste is separately collected predominantly at municipal collection centres, it might be also be collected at the doorstep on demand, but only by charging for that service.

	Separate collection scheme	Home composting	Municipal collection center
Foodwaste	yes (only high-rise buildings)	yes	
Gardenwaste	No (or on demand only)	yes	yes
Residual waste	yes (door to door)		

Municipalities should consider the promotion and co-ordination of collection services on a district level, in order to reduce collection costs; decentralised composting and co-operation with local farmers should be evaluated (see chapter 8.0).

The third situation is applicable to rural areas, with small villages (inhab < 1000 - 1500); in these cases, home-composting can constitute the only tool for food and garden waste management; a limited number of households, either not willing to do home-composting or living in flats, can be provided with a separate collection scheme. In these situations co-operation with local farmers and decentralised composting should be considered first.

	Separate collection scheme	Home composting	Municipal collection center
Foodwaste	No	yes	
Gardenwaste	No	yes	for large amounts only *
Residual waste	Yes (door to door)		

** preferably this can be installed at a farm where the green waste is composted as such or together with animal manure.*

Some general factors influencing the sustainability and acceptance of *biowaste management systems* are listed below (these are not claimed to be comprehensive).

Table 12: Factors Affecting Sustainability of Biowaste Management Systems

Argument	Activity	Remarks
Collection	Type of materials collected	➢ Differentiated collection schemes for kitchen waste and garden/park waste or mixed systems

Argument	Activity	Remarks
	Frequency	➢ Depends on temperature (summer/winter), size of collection bin relative to settlement structure (garden?) and type of material (kitchen waste only?) ➢ Aim: prevent odour and hygienic problems
	Type of collection bins	➢ The higher the volume of the bin the more bulk garden waste ➢ Best performance: weekly collection with biodegradable bags or 20 to max. 40 l buckets per household
	Locality of collection	➢ Door-to-door collection → best performance (high purity; high recycling rates) for pure kitchen waste and combined kitchen & garden waste collection systems ➢ Road container collection → increases impurities for kitchen waste and combined collection systems; decreases capture and recycling rates
	Type of vehicles	➢ Compacting vehicles → are less suitable for kitchen waste (hindrance of pre-sorting of impurities; increased press water) ➢ Bulk trucks with/without compaction ➢ Open lorries without compaction → cheapest and most comfortable solution for hand-picking system for kitchen waste which is provided in compostable bags and small buckets at the kerb side
	Information, support of the public	➢ Regular encouragement for home composting (leaflets, seminars, articles, compost parties, information centre, compost and waste hotline, etc.) ➢ Regular information of inhabitants about what and how they should do the source separation in the household ➢ Support with collection logistics (bio buckets for the kitchen, collection bags (paper or certified compostable transparent ones) ➢ Regular information about the environmental and economic value of source separation)
Treatment	Location of composting plant	➢ … no nuisance (odour, aerosols, dust, 'flying plastics', noise) for neighbours. Therefore composting plants should be located in adequate distance from existing settlements or public recreation areas.

Argument	Activity	Remarks
	Technology	➢ 'Best practice' for all systems of composting in the frame of a Quality Management System (QMS): ➢ Complete receipt control ➢ Immediate treatment of fresh materials ➢ Flexible and controlled moisture, temperature (sanitation) and odour management ➢ Structure material stocks for flexible mixing ➢ Standards for quality orientated production ➢ Controlled leachate water and rainwater collection, treatment and use ➢ External control system (QAS - Quality Assurance System)
Marketing and Use		➢ Quality assured certified composts only (QAS with quality label) ➢ Differentiated product lines and information of customer groups (private gardens, landscaping, land reclamation, agriculture, horticulture (non-food/food)) ➢ Offering compost blends and compost based substrates for the end use (potting soil, greens, sports ground, golf course etc.)

5.0 HOME COMPOSTING AS A MANAGEMENT OPTION [5]

5.1 Home Composting and Separate Collection Of Biowaste – A Complementary System

Since the 1970s, in various publications about gardening, descriptions about how to make compost have been published. To make compost was not something completely new; it was known for example, that with home composting, private households could produce a very useful resource – compost - for the care and improvement of land, and fertilization of gardens – and do so for free!

In districts with a high number of gardens, decentralised composting in gardens can become an important factor in waste management. Data in Chapter 4.4, Table 9 show that this is the case for at least 70% of Municipalities in Slovak republic (with less than 1000 inhabitants).

Still there always will be a demand for an additional collection system mainly for foodwaste (with bio bins). There will never be 100% of all households or other institutions, who are able or willing to make compost by themselves. It has to be stressed that home composting is possible also in apartment buildings *(Community Composting)*, but this needs good organisation and persons (often volunteers), who are willing to do the work. Most of the times in high-rise buildings, the separate collection of biowaste is the only alternative.

Hence, the collection of biowaste with the system of bio bins (separate collection for biowaste) and the composting of biowaste in backyards, are two systems which always complement each other.

[5] We thank Johanna Leutgöb, Environment counselling, Vienna, for providing information on home composting campaigns in Lower Austria (Niederösterreich).

Table 13: Key-elements of a strategy for Biowaste management based on home composting and separate collection for biowaste

1	2	3
As much home-composting as possible in private gardens	**Complimentary the separate collection of organic waste**	**Favouring and focussing on compost plants run by farmers**
No transport of biogenic waste Healthy fertilizer and substrate for gardens Visualization of a natural "recycling" process Little costs for the waste management system (only public relations) No costs for the citizens	A service for people who don´t want to or can´t make compost (escpecially for apartment buildings) recycling of biowaste is guaranteed biowaste is processed at compost plants no biowaste in residual waste	Little transports, as the "recycling" takes place in the region High quality, as farmers have a high interest on good quality compost for their fields Application of compost in farming – improvement of land, fertilizers substitution Additional income for farmers – it is a profession, which is highly under financial pressure Visible for the inhabitants of the region – more identification

A good example on how an integrated programme achieves very good results can be found in the biowaste strategy for Lower Austria[6]. The biowaste strategy for Lower Austria gave the ***framework for the activities on the municipal level*** and therefore had a very strong impact on how biowaste collection systems developed. If there is no such framework provided by a government or county administration, municipalities have to do this without support.

The composting of organic materials is an ideal model for an effective recycling management based on the natural cycle. It should be based on sustainable, flexible, natural and economic principles. A decentralized management of biowaste is best able to fulfil these requirements.

[6] in 1995 the Austrian *Ordinance on Separate Collection Organic Waste* made separate collection of biowaste compulsory. Since the beginning of the 90ies federal states and communities began to develop biowaste management systems, to be able to meet the exigencies of the biowaste regulation.

Therefore the Lower Austrian biowaste management is based on the 3 key-elements shown in Table 10.

5.1.1 Waste Fee Systems (hints)

Adequate waste fees and charges can help local authorities to steer households towards home composting instead of demanding separate collection services.

If **flat-rate charges** are in place (per household and/or per capita), a partial reduction of the charge for those engaged in home composting will encourage families to start participating in home-composting activities. The amount of the reduction should never exceed 20-25% in order to keep it as an incentive, not a payment for waste avoided. An effective example can already be found in some Slovak municipalities. For example, the Municipality of Palarikovo (see chapter 5.7 for details) has reduced the waste-charge in order to stimulate participation at recycling schemes and home-composting:

- households doing home-composting and separate collection:
  charge per inhab. = 180 SKK/y
- households not doing home-composting
  charge per inhab = 280 SKK/y

Bin fees can be introduced where residual waste and food waste are collected at the doorstep. A general bin/bag fee should be established to cover collection and disposal cost for residual waste. If the volume of the buckets for food waste collection are kept relatively small (up to 30 l) this prevents the mixed delivery of food and garden waste, hence garden waste will not fit into the buckets and families will have to compost it (or bring it to municipal collection centres). Even so households, who order a bio-bucket, should have to pay an additional **fee for the bio-waste collection**. This system remunerates all households, who take care of <u>all</u> their biogenic waste by themselves – they prevent waste, but work for it in making compost and contributing to a healthy environment. Hence within a fair fee system it is possible to promote home composting and thus *waste prevention.*

Further readings, regarding waste charging and financing tools, besides the amount of the biowaste fee will be described with more detail in a specific deliverable about economic instruments. Obviously very low fees might weaken the motivation for households to make compost in the back yard and excessive biowaste-collection-fees might discourage source separation of biowaste.. Even so it might be advisable to cover main-parts of the investment

cost (regarding source separation schemes for biowaste) by adding them to the fixed part of the waste fee; in the latter case, all households have to pay for it, even if they don't participate in separate collection of biowaste.

5.2 Strategies to Make Decentralised Home Composting Reliable and Successful

Especially in rural areas home composting is not unknown to people. People do it, because they:

- appreciate the beneficial qualities of compost,
- don't want to have to transport their garden waste to a collection point, or
- they have always done it (it is a habit).

Usually households do not process the entire amount of biowaste, which arises in both kitchen and garden. To ensure that home composting makes a relevant contribution to the ovrall management of biowaste, and to ensure that the activity is performed in an effective manner (to produce a good quality product), it is necessary to carry out public relations work and promotional activity in order to:

- tell people about the benefits of home composting – for themselves and society
- provide advice concerning methods, tools and tips for home composting
- convince people to begin home composting, where they have not done so previously
- provide background information on the environmental problems of landfills and waste disposal
- provide information about the legislative framework, (e.g. waste fees which are more expensive, if people have to order a biowaste bin)

In addition to public relations and promotional activity, some practical tools can help to encourage home composting, and also separate biowaste collection. Such tools include:

- Small biowaste containers for segregated collection of wastes from the kitchen – distributed for free or at low costs (financing with a sponsor) to all households;
- biowaste bags of paper for the kitchen-bin;
- compost boxes (or composters);
- a shredder service at municipal collection centers, or operated at specific locations on a mobile basis at weekends.

In addition to the above, it may be useful to consider establishing networks of community-based compost advisers, or so-called Compost Counsellors, or Master Composters, as happens in parts of the United States and Flanders, and in the Lower Austrian example described below . These people may have specific training to enable them to help solve problems in specific neighbourhoods, or they may be responsible for showing how to do home composting at demonstration sites established at HWCs.

5.3 Measures to Promote Home Composting

Home composting can be promoted by concentrating efforts and expenses on 3 different topics, that are:

- Information and educational activities
- Effective support of households
- Distribution of tools (composters, biobins, etc)

The main features and purposes of these measures are outlined in following chapters

5.3.1 Public Relations Work

Measures in public relations should be designed in three phases. Part of the motivational phase is the preparation of the project, involving all important stake holders (i.e. NGOs, municipal deputies, teachers, interested citizens, …), but also, crucially, the citizens.

Phases :	**Motivation**	**Information**	**Reflexive Phase**

Questions:	*What, why ?*	*How ?*	*How was it ?*
Goals:	Create awareness	change of behaviour	Celebrate success, corrections

5.3.2 Mailings

Regular information for citizens should show why composting is an issue in the municipality, and give information about home composting, as well as announcing activities like compost parties, and public talks. It should also describe how the biowaste management will be organized in the future (fee, bio bins).

5.3.3 Compost Parties

Compost parties were a very successful way, in Lower Austria, of teaching people how to make good compost. People come together in a garden, in a school or at an event, and compost counsellors demonstrate, practically, how to make compost. There is usually something to drink and to eat, and people talk and stay together in a pleasant atmosphere.

5.3.4 Lectures and Talks

Lectures and talks about natural gardening, making compost, or separation of waste in general are a good way of engaging people who want further information.

5.3.5 Event(s)

An event can be the highlight of a promotion campaign for home composting, where all stakeholders – schools, NGOS, VIPs, etc. - participate. There are no limits for creativity in organizing an interesting “compost event”. It is very useful if media interest can be generated around these types of event to promote the activity.

5.3.6 Information Materials

Brochures and leaflets about home composting should be available for every household.

5.3.7 Projects in Schools and Kindergarten

The integration of schools and kindergartens in a promotional campaign is a crucial factor. A careful handling of waste establishes a basis for future life – children are our future and have to

understand this. Children and students are very sensitive to environmental issues, and biowaste and compost provide good examples of natural circles and an interesting field in biology, suitable for development in the school curriculum. There is also a saying that, "If you catch children, you also catch their parents". Environmental work in schools often has a very strong impact also on parents.

5.3.8 Shredder Service

Because of the atmospheric emissions released, it is not advisable to burn bulky garden waste simply to get rid of it. On the other hand, wood chips are a very good material to put into home compost units. Because of its rough structure, it allows air into the compost. For garden owners, however, it is difficult to chop up twigs and other wooden material.

A shredder service can be introduced twice a year (spring and autumn). People sign up if they have something to chip and the shredder service moves door-to-door and chips up bulky garden waste. The material should in any case remain at the houses, because it is a good material for the garden, but also, because carrying the chopped material away would be expensive. Participating in the shredder service should not be charged for – it is a measure to help garden owners in processing their biowaste materials. It also helps, in that bulky garden waste will not be disposed of somewhere in the landscape, or burned. Additionally a permanent service can be established at municipal collection centres.

5.4 Instruments and Tools

The separate collection of food waste in the kitchen can be enhanced by supplying households with a proper set of small bins (6-12 litres) and biodegradable bags (paper or starch), that allow them to easily manage those fractions.[7]

The distribution of pre-fabricated composters for free to families should be carefully considered, since the investment cost can be remarkably high (for the municipality). A cheap, do-it-yourself solution can often be the most effective instrument (see Table 14), in terms of :

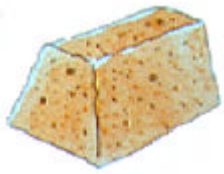
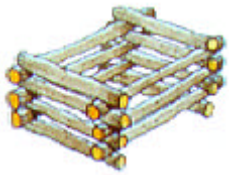
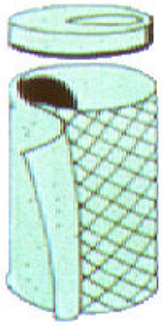
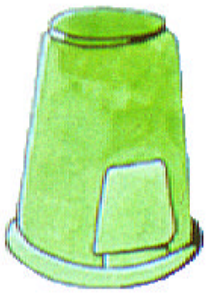
- Guaranteeing aerobic conditions

[7] For more details see chapter 6.1.

- Allowing simple activities as turning and mixing
- Limiting the influence of drying and wetting
- Collecting the mature compost

A broad estimate of costs is added in the last row. Whilst presenting home-composting at events, in schools or for contests, it is useful to have some of these materials. In these situations sponsors can support these materials.

Table 14: Typical tools for performing home-composting and investment cost

	Natural	**Do it yourself**	**Do it yourself**	**Pre-fabricated**
				
Aeration and oxygen supply	☺	☺	☺	☹
Mixing and turning	☺	😐	😐	☹
Independence from weather condition	☹*	☹*	☺	☺
Collection of mature compost	☺	😐	😐	☹
Cost range (SKK)	-	-	200 - 700	1200 - 4000

*Note: * if not covered with fleece that drains of the rainfall*

5.5 A Practical Example - The Approach of Lower Austria

In the following sections, we outline practical details of the strategy developed by the *Federal State of Lower Austria*, a good example of how an integrated programme for flexible and sustainable biowaste management achieves very good results in situations with small towns and rural areas. The key elements of the approach were described previously in Table 10. The key outcomes are shown in Table 15.

Table 15: Key-figures of Lower Austria MSW strategy for biowaste

average inhabitants per household	2,5
potential of kitchen waste per inhabitant/y *	100 kg/a
potential of kitchen waste per household/y *	250 kg/a
potential garden waste per family house with garden (size of garden about 500 m2): 1.000 kg/a, suitable or processed in composting: 500 kg/y **	500 kg/a
Biowaste, which remains in private care per house with garden	750 kg/a

*Source: * Raninger 95; ** Lower Austrian Garden study, 2002*

5.5.1 Measures of the federal state authority

The measures shown in chapter 5.3 have been put into practice since the beginning of the 1990s by the Federal State of Lower Austria, and various types of information were issued. Public relations were, and still are, an inevitable part of a decentralised biowaste management. Basically people need information regarding:

- why they should collect biowaste separately,
- how to make high quality compost, and
- how to manage it properly

A **first measure** was to raise public awareness about **how to make high quality compost**, and how to manage it properly. This information was provided through:

1. The Environmental Journal of Lower Austria (4 times a year)
   Target groups: municipalities, municipal deputies, environmentally interested persons, experts, teachers…
   Contents: information on various types of composting and biowaste treatment (home composting, farming composting etc.), practical examples of other municipalities and countries, best practice examples, planning data, etc.

2. Brochures, leaflets, posters
   Target groups: citizens, multipliers
   Purpose: support for the local waste management activities, information for citizens

Information materials to be provided for citizens and stakeholders were produced for home composting, composting at appartment buildings, and information materials for schools. Municipalities, citizens and stores could order these materials and use them for their information work on site.

A **second measure** was to train and establish a group of **composting experts*;*** about 250 people attended a special training to become compost experts and graduated with the degree: "compost counsellor". The Federal State of Lower Austria designed and financed this training. It lasted about 10 days (grouped in sessions of three days each within a year)

1. Training of compost counsellors
   Target group: municipal employees and deputies, farmers, teachers, private individuals, people from NGOs
   Purpose: give adequate training on home composting, biowaste management in the municipality, agricultural composting.

These compost experts applied their knowledge in the region. They are the main reason for the success of the Lower Austrian strategy. They were motivated advocates of composting and "sold" the idea to the people. They also were involved in establishing biowaste collection systems – with home composting as an important part – in the municipalities and waste associations.

A **third measure** was to set up a **Network of experts;** these experts where complimentary to the local compost counsellors (who went through this training programme) and they additionally helped as counsellors. They gave lectures, advised municipalities or held "compost parties". Many of these experts – especially for home composting – came from the *eco-counselling* organisation, an NGO, which is funded by the Federal State of Lower Austria.

A **fourth measure** was to organise specific **Meetings and congresses**, in order to exchange experience and to strengthen the network of all players in the compost scene.

A **fifth measure** was the institution of a **waste and compost helpline**, a public telephone number where everyone could ask for information

A **final measure** was to provide technical planning guidelines for composting plants: About 80 composting plants are operating in Lower Austria. Most of them were built in the beginning of

the 1990s, and more than half of them are agricultural composting plants. Planning guidelines were put in place, which helped in designing the right size of plant, and also ensured facilities were guaranteed to meet legislative requirements.

All the measures described above, together with the expected Organic Waste Ordinance, formed the framework for organic waste management for waste associations[8] and municipalities.

5.5.2 Results

In Lower Austria Home composting is a very important and sustainable factor in the management of biowaste (foodwaste and gardenwaste) and about 58% of all households process their biowaste in the garden. It becomes a strategic tool, especially in rural areas, where the number of households who compost by themselves goes up to 80% to 90%, and still higher in some cases.

The example of the district of Bruck shows (Table 16), that home composting is a powerful measure in waste management. About 73 % of all households with gardens mainly process their biowaste in the backyard. Only 27% use the separate collection scheme (bio bin), and they pay for the service.

After over 10 years of separate collection of biowaste and home composting in Lower Austria, there is a tendency towards the use of biobins. The collection of biowaste through the biobin system has increased from about 56 kg/Inh/y in 1994 to 80 kg/Inh/y in 2001. Many people use the biobin for excess materials and pay for it, but still have a place for carrying out home composting in their garden. The amounts of biowaste (home-) composted and separately collected are shown in Figure 8.

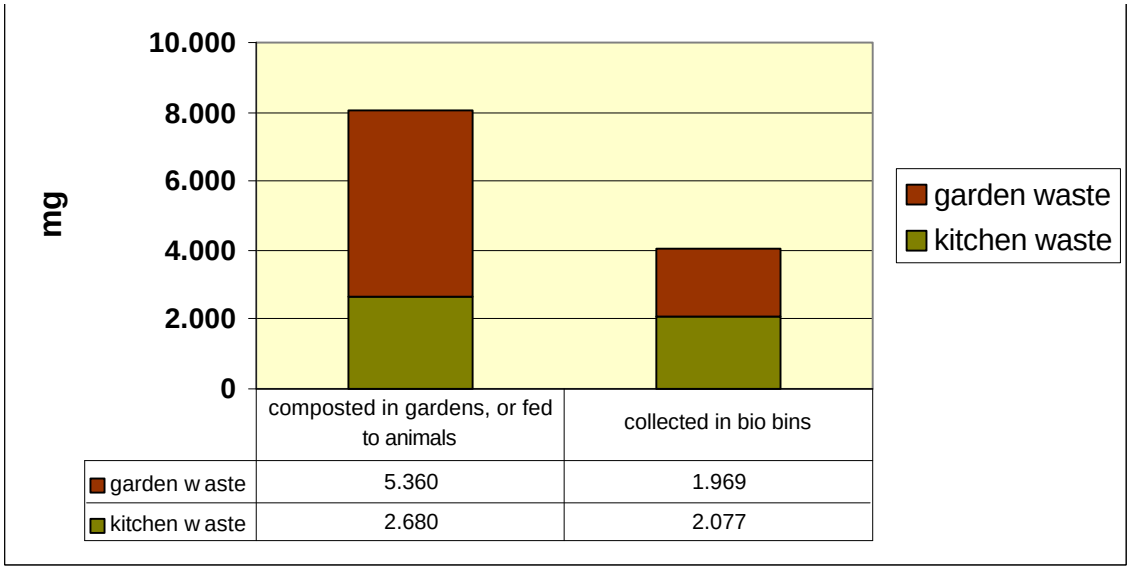
[8] Waste union: municipalities of a district form an operative union to organise the waste management.

Table 16: Results of home composting in the Waste Management District of Bruck - Lower Austria

Households in total	19028	100 %
Households in apartment buildings	4372	23%
Households in family houses with gardens	14656	77%
Households in family houses with garden without composting	3937	27%
Households in family houses with home composting	10719	73%
Total households without home composting (apartment buildings included)	8309	44%
Total households with home composting	10719	56%
Mg kitchen waste composted in gardens, or fed to animals	2.680	
Mg garden waste composted or used otherwise in gardens	5.360	
Total Mg biowaste processed in households	8.039	67%
Mg kitchen waste collected in bio bins in apartment buildings	1.093	
Mg kitchen waste collected in bio bins in family houses	984	
Mg garden waste collected in bio bins in family houses	1.969	
Total Mg biowaste collected in bio bins	4.046	33%
Total Mg biowaste home composting, and bio bin collection	12.085	100 %

Note: 1 Mg = 1 000 000 g = 1 tonne

Figure 8: Amounts of biowaste separately collected and home composted - District Bruck/L, Lower Austria



Source: The data are generated from the yearly waste report of Lower Austria 2001, data from the waste union of Bruck/L (Jan 2003), the biowaste study of the environmental ministry in 1995, Dr. B. Raninger, and the lower Austrian garden study, published by the government of Lower Austria, Vienna 2002.

Since the year 2000, home composting has been integrated into a campaign for ecological gardening, which points out the positive environmental effects of compost (substitution of mineral fertilizers, better health of plants, improvement in soil fertility).

Finally **the social aspects** of home composting have to be underlined. It is easy to manage for people in rural areas, and it does not cost anything. People in apartment dwellings also can establish a community composting system and thus save money. If it is not possible to establish a community composting network in an apartment dwelling, people can share a biobin, so again, the costs can be kept low.

5.6 Wolkersdorf – a well documented project on promoting home composting

In 1993 and 1994 the city of Wolkersdorf[9] in Lower Austria performed a well documented project to promote home composting and to introduce separate collection of biowaste. The project was supported by the government of Lower Austria.

Figure 9 shows the time flow of measures which took place in Wolkersdorf. The project lasted one year. Within this period, people had to be motivated, informed and after that had to decide whether to make compost on their own, or to order a bio bin.

5.6.1 Results

The results reported below were partly generated from waste analyses, which were performed in March 1993 and March 1994. Data also were derived from the official waste report which every municipality is required to present every year, and were complemented with data from the research project.

The waste analysis showed, that biogenic waste was sharply reduced within the project. At the same time the separate collection of other recycables like paper etc. was enforced, so not only biogenic fractions in waste were reduced.

[9] Wolkersdorf is a municipality of about 7000 inhabitants north of Vienna.

Figure 9: Example of timing for the promotion of home-composting (in months)

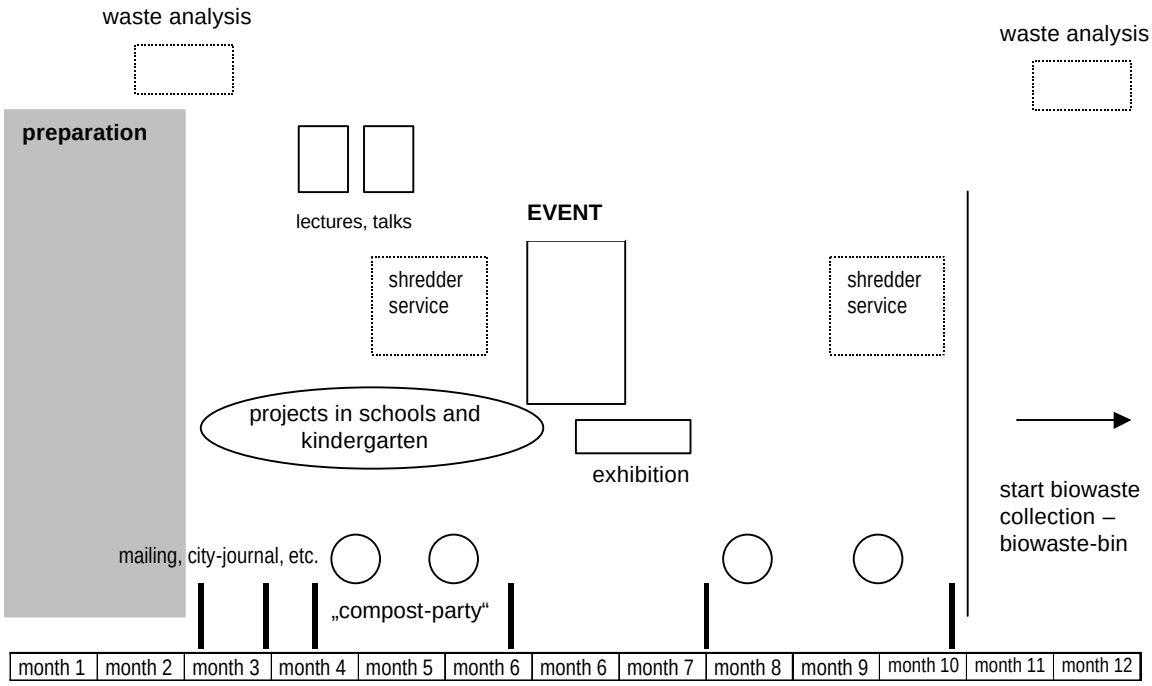
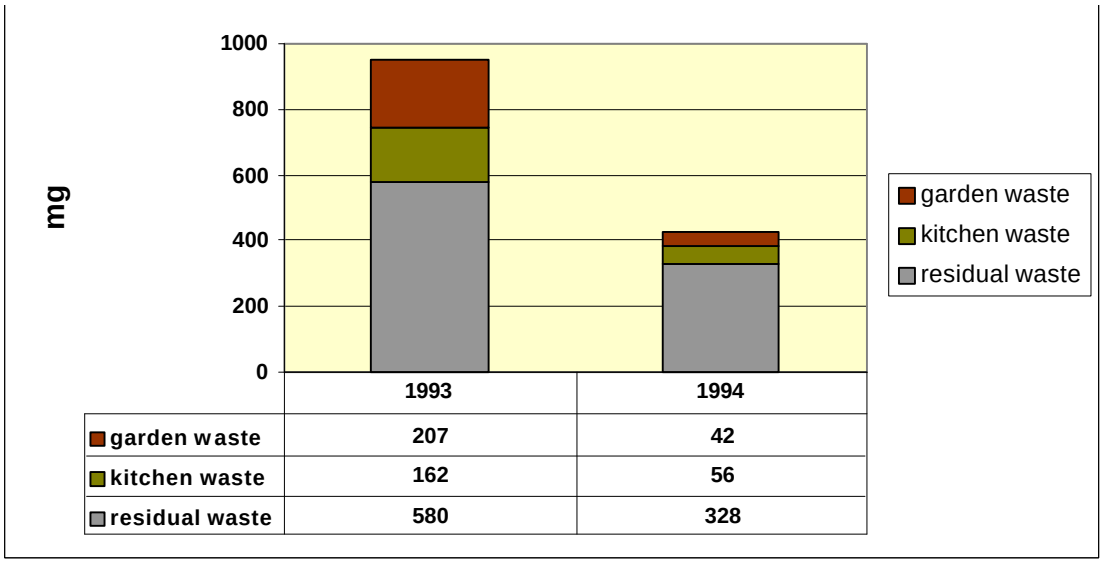
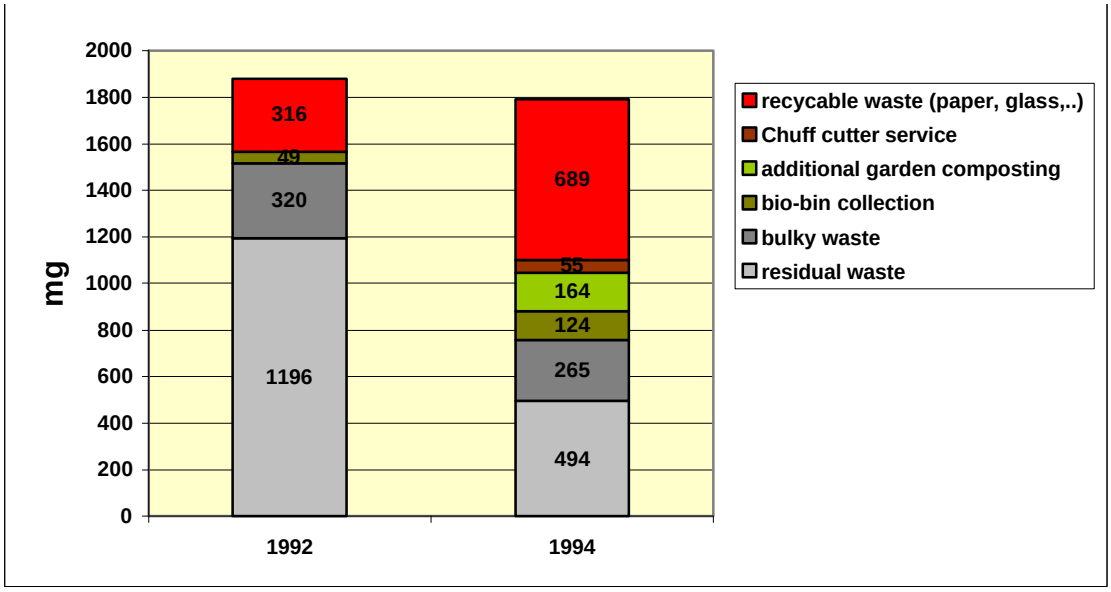


Figure 10: Reduction of biogenic materials in residual waste - waste analysis 1993/94



	1993	1994
garden waste	207	42
kitchen waste	162	56
residual waste	580	328

Figure 11: Waste amount in Wolkersdorf 1992-1994



As a result, the quantity of residual waste fell sharply. Part of the reduction was due to an enforced collecting of recycables (paper, glass, metals, packaging) (responsible for 53% of the decline). About 42% of the fall was due to the reduction contributed by the separate collection of biowaste and home composting. Home composting in this city processed about 70% of the biowaste. 30% of the biowaste is collected by the bio bin collecting system.

Around 164 t of biowaste no longer have to be collected by the waste collection system. In fact, the amount of biowaste being processed in gardens is much higher, since many households were already engaged in home composting before the project started.

5.6.2 Situation in Year 2002

Since 1994, more people have ordered a biobin, even though the biobin service in year 2002 cost about € 70/ year. Still only about 30% of the households in family houses with gardens use the biobin and 70% make compost in their gardens. 240 l biobins are mainly used in apartment dwellings.

It is also known, that many households use both systems. Some particular biogenic materials (such as cooked foodstuff) are disposed in the bio bin, but still there is a compost place in the backyard and the compost is used in the garden.

Table 17: Wolkersdorf : number of biobins for biowaste collection in the Municipality before promoting home-composting (1994) at after (2002)

N° of biobins	1994	2002
bio bins 120 l	367	655
bio bins 240 l	36	36

5.7 Home Composting in Palarikovo Municipality

Palarikovo is a municipality of 4400 inhabitants situated in a rural area near Bratislava. 97% of all families live in semidetached houses.

The municipality has succeeded in establishing an effective scheme for:

- Enhancing separate collection of packaging waste and bulky waste;
- Reducing the amount of biowaste inside mixed waste; and
- Optimising the collection systems by realising a Municipal Collection centre.

5.7.1 Waste Management System

In 2001, the municipality started source separation and collection of dry recyclables and bulky and hazardous waste at all households (at the doorstep). Each household is equipped with a 150 l PE-bag (re-usable) collected every 2 months. Different bags are provided for plastic, paper, glass, and multilayer-packaging. Hazardous waste can be delivered during collection day directly to a collection vehicle stopping at the doorstep.

A Municipal Collection Centre is already working and being further developed, where people are allowed to deliver for free all kinds of recyclable and bulky waste. Shredding of garden waste is done with a municipal shedder.

Residual waste is collected every 2 weeks by means of 110 l bins (see picture) at the doorstep. Home composting of food and garden waste is established at 97% of all households, due to an intense promotion and information campaign organised by the municipality.

In the year 2002 Palarikovo collected 1200 t/y, or about 270 kg/inhabitant of waste. By 2003 the residual waste had fallen to about 550 t/y and the collection of materials for recycling was 180 t/y. This represents a reduction in the annual amount of waste of about 107 kg/inhab. It should be noted that this figure, when estimates as a proportion of the overall quantity collected in 2002, suggests a reduction of the order 40% due to home composting. This is in line with estimates for the proportion of waste which is likely to be biowaste, established in Chapter 3.0.

5.7.2 Waste Management Cost

The collection of residual waste and recyclables is performed directly by the municipality, which owns the vehicles, and with labourers employed by the municipality. The system configuration is as follows:

- residual waste collection: team (1 compactor, 1 driver, 1 collector)
- recycling waste collection: team (1 open skip, 1 tractor&1trailer, 2 drivers, 7 collectors)

Workers are only partially occupied with municipal waste collection during any year.

The costs for performing waste collection and disposal are estimated by the municipality to be 800.000 SKK/y, giving a mean cost of about 182 SKK/inhab. Details follow:

- residual waste collection 298.500 SKK/y
- recycling waste collection 100.000 SKK /y
- disposal of waste 401.500 SKK /y
- TOTAL cost 800.000 SKK /y

The following table shows the revenues for recycling different separately collected materials. The incomes from the recycling fund (280.000 SKK /y) and from the sale of materials (180.000 SKK /y) reduce the total cost by almost 50%.

Table 18: Palarikovo municipality: Recycling - 2003

Material	Quantity (t)	Revenue (SKK/tonne)
Paper	60	1500-1800
Tetrapak	42	500
PET	17	6000-7000
Dense Plastics (other)	8	
Plastic Film	7	
Glass	14	400 (dark) 800 (clear)
Accumulators	7	
Bulky (mostly scrap)	25	
Metals		2000-2900

5.7.3 Charging

Charging has been varied in order to stimulate participation at recycling schemes. The charge per inhabitant rises from 180 SKK/y for households collaborating with the source separation schemes, up to 280 SKK/y for those not doing any recycling and home-.composting. Hence, total revenues (allowing for some non-recycling households) are approximately 805.200 SKK/y. Charging of households happens two times each year, in order to allow for some variation in cost between those households doing separate collection and those who are not (this allows the change to be made more than once per year).

5.8 Cost-benefit Analysis of a Promotion Strategy for Home-composting

Home composting as a tool for managing biowaste separation and recovery needs an adequate promotion strategy and technical support. In small, rural municipalities the effort should be optimised by promoting it on a district area.

The following Table summarises the results of a rough simulation for home composting to be promoted in an area of small municipalities covering 20.000 inhabitants. The simulation considers:

- The amount of foodwaste (200 g/inhab/day) and of garden waste (3kg/m^2) composted, hence not delivered to the collection scheme;

- The saving on waste disposal of 1000 SKK/t, a low price, comparing to EU standard-cost for disposing waste;
- The cost for 4 persons (tutors), charged with supporting families starting home composting activities;
- The cost for manuals and leaflets explaining how to perform home composting;
- The cost of equipping 50% of all families participating with a plastic-composter (this is an optional feature and is cost intensive - a cheaper solution involves using a self-made composter or - see also tools listed in Table 14).

The ***break-event point*** refers to the situation when the savings on disposal cost are equal to the annual cost for promoting the activity. In this very basic analysis the BE-point ***is reached by involving*** a minimum 40% of all households in the area.

The annual cost per family participating is estimated at about 360 SKK, assuming the programme is to be performed for 5 years (amortisation period of the composters). It has to be stressed that a participation rate of about 50% and more should be reached in order to reduce, systematically, the amount of biowaste inside the residual waste stream and to establish home-composting as an effective tool to divert biowaste from residual waste.

Table 19: Engineering of home-composting promotion – cost are in € (1 € = 40 SKK)

Basic data	**total inhabitants**				**20.000**
	Total families				**7.000**
	Mean cost for info-materials (ex composting manuals)				**3,00**
	Coverage of composter cost				**100%**
Organic waste production & disposal costs	**Inhab/family**				**2,86**
	Kg/inhab.day of FOODWASTE				**0,200**
	dd/year				**350**
	Mean surface of gardens				**200**
	Production of GARDENWASTE (kg/m^2)				**3,0**
	Percentage of GARDENWASTE actually disposed				**50%**
	Disposal cost (€/kg)				**0,025**
Training amd education	**Composting tutors**	**n°**			**3**
	Unitary cost (part-time job)	**€/y**			**3.000,00**
	Supervisor	**n°**			**1**
	Unitary cost (part-time job)	**€/y**			**1.000,00**
	Training of tutors	**€**			**600**
Composters	**Unitary cost**	**€**			**50,00**
	Coverage of composter cost				**100%**
	Amortisation (y)				**5**
	Annual rate			**-**	**11,55**
	% of families with composter				**50%**
ECONOMICAL PARAMETERS	**Cost for composters**	**fam/y**	**€**	**-**	**5,77**
	Cost for info-materials	**fam/y**	**€**		**3,00**
	Mean total cost per family	**fam/y**	**€**		**8,77**
	II Break-event			**2.845**	
	% families			**41%**	
	% of families with composter				**50%**
	n° composter necessary				**1.423**

6.0 SCHEMES FOR SEPARATE COLLECTION OF FOODWASTE

Running source separation for food waste, both at households and for large producers, implies the need for tools to face problems linked to the specific features of such a material. These include its fermentable nature and its high moisture content. In this respect, a service which is comfortable, and where households are provided with tools to avoid nuisance, will result in enhanced participation and will thus result in a higher collection quantity/quality.

These issues have to be best tackled through:

- a relatively "intensive" collection schedule (intensifying frequencies depending on seasons and/or type of dwellings);
- the use, in most cases, of collection systems "at the doorstep" so as to have them more "user-friendly" and enhance the participation rate.
- the use of watertight, transparent receptacles to confine the waste ("Biobags").

These features will be described in the following sections.

6.1 Tools and Instruments to Enhance Source Separation

Intensive collection schemes for food waste imply that each waste producer (family, shops, private enterprise) must be equipped with specific tools (bags, buckets, wheel-bins) that can be used to easily manage putrescible materials (including cooked substances such as meat, fish, soups, food scraps, etc). A range of specific tools will be suggested and considered as "personal" equipment to be given to waste producers.

6.1.1 Tools for Households

The most important piece of advice is to make the source separation of food waste convenient and manageable in a clean way within the kitchen. This can be achieved by equipping each family with:

- **A small-bin** of 6-10 l to be put inside the kitchen; and
- A set of transparent bags to be used as a liner inside the small-bin.

The small bin-size prevents the delivery of bulky materials (e.g. bottles, cans), allowing higher biowaste purity. The use of the bags is intended to:

- make it possible to collect even meat and fish scraps along with vegetables and fruit residues, avoiding nuisance generally related to delivery of "loose" material inside the bin; and
- prevent pest attraction (insects) and production of leachate, whilst keeping the bins as clean as possible (from food waste).

The combined use of bins and bags is intended, therefore, to enhance overall captures of food waste which, in turn, allows a significant reduction of putrescible materials inside residual waste, and hence a reduction in collection frequency for residual waste.[10]

Once full, **bags** have to be placed **inside** buckets and wheeled bins given to each household, with their volume corresponding to the effective production of foodwaste. The collection tools will be:

- **buckets** (20 to 30 litres) - in areas with detached houses and gardens so as to reduce the pick-up time for each dwelling (loading is manual) and prevent households from delivering garden waste inside the bins; and
- **wheeled-bins** whose capacity usually ranges from 80 to 240 litres where the type of dwelling is flats in high-rise buildings. One wheel-bin is for 10 to 20 families depending on the collection frequency.

Buckets and wheeled bins will be put on the kerb on the day of collection and hence are part of the collection scheme itself.

[10] See chapter n° 6.4.

Figure 12: Bins, bags and buckets appropriate for separate collection of foodwaste

small bin (6lt) for easy separation of foodscraps at the kitchen	Enclosure of foodscraps in watertight, transparent **bags**	**Bucket** (20-40 lt) for collection at semi-detached households	**Wheelbins** for families living in flats and high-rise buildings
			

6.1.2 Tools for Commercial Enterprises

Commercial enterprises producing large amounts of foodwaste include:

- restaurants, take away and coffee-shops, canteens
- canteens at schools, university and hospitals; and
- supermarkets, fruit and vegetable shops, public marketplaces

In the case of bars, and take-away stands producing small amounts of foodwaste (amounts comparable to those of a family), the same collection tools given to households should be used. For larger producers the collection tools' volume must be enlarged. The collection tools will be:

- one or more **wheeled-bins** whose capacity usually ranges from 120 to 240 litres
- in the case of supermarkets, open-markets and flower shops the container size can reach up to 600 litres**.**

A **liner** can be placed inside the wheel-bins, in order to keep them clean and reduce the demand for washing. Generally the latter activity is to be done by the producers.

6.1.3 Choosing the Materials for Bags and Liners

Bags and liners can be made of biodegradable and of plastic materials:

- Biodegradable (made of modified starch or paper)
- Plastic (transparent polyethylene)

Bags are defined as biodegradable provided they comply with standard test methods for biodegradability/compostability (e.g. CEN standard EN 13432 "requirement for packaging recoverable through composting and biodegradation"). Among materials that comply with such standards, corn-starch based materials are the cheapest ones for the time being, and are the most widely exploited in those situations where the collection of food waste is run through the use of biobags (e.g. Italy, Spain, Norway).

Bag materials should be chosen considering also the characteristics of the composting plant and of the recycling options. Plastic bags are cheaper, but lead to a huge increase in plant-costs for the equipment (bag openers and wind screens) and for the disposal of rejects, insofar as such equipment implies a much higher percentage of compostable/composted materials being discarded inside the rejects. Some detailed comparative assessments have recently led to the preference for the use of biodegradable bags instead of the combined system "PE bags + specific equipment". Therefore municipalities and districts should opt for the use of biodegradable bags, since they facilitate the composting and recovery of biodegradable material delivered to composting plants. For areas that foresee decentralized or agricultural composting the use of biodegradable bags should be compulsory, since those plants usually lack devices for separating the contaminating plastic fraction.

Typical prices for bulk sale of bags and liners to be used for collection of food waste are reported in Table 22. Prices for biobags have been recorded on the Czech and Italian markets, which might be assumed as a reference condition in the long run due to the full development of marketing in Slovakia.

A minimum set of 50 to 100 bags/year should be provided to each household, in order to enable them to effectively participate in source separation of foodwaste.

6.1.4 Tools and Volumes for foodwaste collection

So as to confirm the correctness of the tools described, we briefly show what volumes and weights are to be expected while performing door-to door collection schemes. If we assume a medium daily interception rate "p" of food waste at households given by:

p(1 inhabitant) = 200 g/day

we derive that the weekly production "P" of a family of 3 persons is:

P(f) = 200 g x 3 inhab x 7days = 4200 g.

Assuming a mean density of 0,6 kg/l we obtain a weekly production "V" of:

V(f) = 7,0 l

Hence the volume of the collection tools (the buckets, bins) will depend on the collection frequency (times/month). The results in Table 20 show how to choose the right collection tools for different types of dwellings (i.e different n° of families per building).

Table 20: Quantities and volumes of separate collection of foodwaste at different dwellings

N° Families/ dwelling	**Annual production (kg)**	**Weekly production (l)**	**Bucket (30 lt) – manual-loading**	**Wheel bin (120 lt) mech. loading**
1	220	7	n°1	
2	440	14	n°1	
4	879	28	n°2	
8	1.759	56	n° 2 – 3	
20	4.397	141		n°1

An overview of different tools to be used in door to door collection schemes for foodwaste is outlined in Table 21.

Table 21: Collection tools for food-waste (door to door collection schemes)

	Families in detached and semi-det. houses	**Families in apartments and high-rise buildings**	**Commercial activities (big producers)**
Separation at the kitchen	**Small bio-bin & set of bags**	**Small bio-bin & set of bags**	
Collection of food waste (at the doorstep)	 (buckets)		
Emptying	Manually	Mechanically	Mechanically

6.2 Collection Frequencies

The average collection frequency of mixed waste (residual waste) ranges from 2 times/month to 1time/week, and higher emptying frequencies are applied only for road-containers, positioned in high-rise building areas, in order to assure sufficient collection volumes.

Therefore the national prescription for a minimum emptying frequency of 1 collection every 2 weeks for waste should be applied to the putrescible fraction of waste, intending to assure public health and hygiene.

Food waste collection from **households** has to be performed relatively intensively, providing:

- A minimum of 2 collections per month
- An increase up to 4 times/month or more in warmer seasons (typically June, July, August)
- For specific **commercial enterprises**, producing large quantities of foodwaste, a specific collection round with a higher frequency (1/week) may be planned and run in resort places where density of restaurants and canteens justifies such scheme.

The use of bags and liners described in chapter 6.1 has the advantage of keeping the collection bins as clean as possible and this, in turn, makes it possible to cut down the frequency of emptying and washing as shown in chapter 7.3.1. Actually, in many cases where such bags are being adopted, bins are considered as personal equipment, and so are washed by households and enterprises.

6.3 Investment Cost for Collection Tools

Table 22 shows the typical cost-range for different tools used to perform source separation of foodwaste. Prices have been recorded on the southern-EU market, which might be assumed as a reference condition in the long run due to the full development of marketing in Slovakia.

Table 22: Prices for tools to collect foodwaste

Tool	Volume	Price range (SKK)
Polyethylene bags	6.5-10 lt.	0.52 - 0.72
Biobags (corn-starch based materials)	6.5-10 lt.	1.3 - 1.6
Biobags (paper)	12 –15 lt	2.1 - 2.6
Liners (corn-starch based materials)	120 – 240 lt	16 – 18
Liners (paper)	120 – 240 lt	---
Small bin	6 – 12 lt	60 – 120
Buckets	20 - 40 lt.	90 – 180
Wheel bins	80 - 120 lt.	900 – 1120
Wheel bins	240 lt.	1000 – 1300
Containers	600 - 1100 lt.	6000 – 12000
Container (sealed)	5000 – 8000 lt	80000 – 104000

Prices are without VAT; 1 € =40 SKK

6.4 Integrating Residual Waste and Foodwaste Collection

One finds a very important interaction between:

- increases of captures of recyclables;
- smaller quantities of residual waste to be collected and disposed of; and
- smaller volumes of bags/containers required for its collection

Needless to say, a growth in the capture of dry recyclables – namely the most bulky ones, e.g. paper, card and plastics – allows a smaller volume of containers/bags for residual waste. This in turn further promotes the diversion of dry recyclables into proper streams. Furthermore, the implementation of intensive, high-diversion schemes for food waste reduces significantly the presence of putrescibles inside residual waste. This in turn allows:

- a further diminution of volumes provided for the collection of residual waste (though the reduction volume is much less than from bulky dry recyclables), and
- most importantly, a lower frequency for its collection – which further promotes the diversion of putrescibles inside the stream of compostable materials and keeps costs down.

Simplifying the concept we could say that:

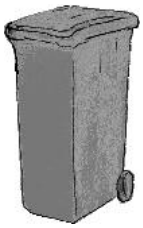
Current situation
Mixed waste collection 3-4 times/month (generally 1/week)

Integrated scheme
Residual Waste 1-2 times/month
Foodwaste 2-4 times/month

The collection of residual waste should therefore consider the adoption of bags or small bins whose volumes depend on the type of dwellings (number of households per each pick-up point). In order to achieve overall savings on the cost side, large-volume containers may be considered only for:

- sparsely populated settlements (rural sites) where bring-in schemes make it possible to have a "gathering point" for various families, thereby avoiding the cost increase which might be related to a collection at the doorstep in such situations.
- high-rise buildings with more than 20 families, where a single pick-up for many persons can lead to a sharp reduction of costs for collection

Figure 13: Overview of tools for residual-waste collection

Type	**Transparent bag**	**Bin**	**Wheel-bin**	**Container**
				
Volume	30 - 80 l	80 - 100 l	100 - 360 l	600 - 1100 l
Emptying	Manual	Manual (with sacks provided to families)	Mechanical	Mechanical

Such approaches also make it also possible to implement various types of PAYT[11] schemes at a later stage, inasmuch as they are mostly related to a household or a small number of households (in high-rise buildings) and they may be fitted with various types of devices to check/register the quantity/volume/frequencies of deliveries (strap-off badges, tags, stickers, weighing chips).

The argument regarding waste fees is further developed in a separate deliverable under this project, "Proposal on economic instruments".

6.4.1 Tools and Volumes for Residual Waste Collection

Arguably, the most important parameter to design the collection of residual waste is the specific volume (litres per person and week -Table 23). This parameter may influence the delivery of bulky recyclables, such as paper, plastics and glass, into the proper collection system. Admittedly, such volumes may be provided – in most cases - by means of bins or bags (in such cases as high-rise buildings also through big containers).

Both bins and bags belong to households/groups of households and have to be placed at the kerb on the collection day and therefore constitute a powerful tool to make households responsible for the waste that is contained.

Table 23: Tools Proposed for the Collection of Residual Waste

Tools for residual waste collection			**Specific volume (l/inhab/week)**					
			Emptying frequency					
	Bag/Bin volume		**1/week**			**1/2weeks**		
Dwelling with 2-3 persons	100	liter	33	-	50	17	-	25
Dwelling with 6-10 persons	240	liter	24	-	40	12	-	20
Buildings / houses with 20-30 persons	1100	liter	37	-	55	18	-	28

[11] PAYT =Pay As You Throw

6.4.2 Choice Between Using Bins and Bags

The **choice between bins and bags** may be made considering the following:

- perceived ease of use for delivering them at the kerb;
- health aspects and protection from stray cats/dogs (which may be important in some areas);
- different methods for collection (hand-loading for bags or mechanical loading for wheeled bins) and the impact on time/costs for each pick-up;
- safety for waste collectors (e.g. needles);
- possibility to check – through the use of transparent PE bags - the type of waste contained (which provides a powerful system to drive the households' behavior and to prevent them from delivering recyclables inside residual waste); and
- the way the cost for containers is defrayed over time – this outlay is made all at once in the case of wheeled bins or bins, but occurs evenly over time in the case of sacks.

The choice has to take into account the advantages/drawbacks listed above, as well as:

- What is being used in best practice situations,
- the fundamental need to keep the perception of the overall collection scheme clean and safe, avoiding the massive release of a high number of bags in front of high-rise buildings; and
- feedback from the public concerning what is considered acceptable, which has been recorded in many surveys on customer satisfaction.

Table 24: Bins and Bags: Comparison of Advantages (+) and Drawbacks (-)

	Sacks	**Bins**	**Wheeled Bins**
Easiness and comfort for households	-	+	+
Health aspects / stray cats and dogs	-	+	+
Time needed for each pick-up / collection costs	++	+ (used with bags)	-
Safety for waste collectors	-	+	++
Possibility to check the type of waste	+	+ (used with bags)	-
Starting budget needed (investment cost)	+	-	-

It has to be stressed that switching from collection by means of wheeled bins to a hand loading of bags would enhance the collection efficiency (in terms of the number of pick ups per collector per day), thus contributing to reducing the collection cost. An intermediate result could be to adopt a mixed scheme with:

- bags at dwellings with one or a few households (detached or semi-detached hoses, terraced houses);
- or small bins up to 100 lt fitted with appropriate transparent bags (to be kept in a common place inside the property and to be placed then at the kerb on the collection day); and
- wheeled bins and containers at high-rise buildings with more than 20-30 families, where the longer pick-up time for each bin is more than offset by the number of households that are served with one single bin.

This discussion leads us neatly into a discussion of the economics of the different approaches to collection.

7.0 ECONOMICS: EVALUATING COST FOR FOODWASTE AND RESIDUAL WASTE COLLECTION

7.1 Integrated Waste Management of Wet / Dry Collection

The basic feature of Integrated Waste Management programmes of wet/dry collection is that organic waste collection is seen as part of the re-design of the collection system as a whole. One of the aims of the new system is to remove a large enough portion of putrescibles, and to reduce volume sufficiently, to allow residual waste to be collected less frequently.

In order to do this the capture of food waste through separate collection must be such that its presence in residual waste is cut down to 10%-20% and less in weight. Considering the concentration of materials which occurs in residual waste, and often in Central Europe takes percentages of food waste in residual waste around 30 or even 40%, this implies the need to have a very comfortable and user-friendly collection scheme, so that participation is enhanced.

The importance of this point is economic. If the source separation of food-waste is added as a further service, with no modifications to the previous scheme for MSW collection, the total number of collection rounds and (obviously) the cost of the collection service is bound to increase. But this does not happen if and when food waste collection and the source separation of key dry recyclables are integrated within the overall collection scheme. Separating out food waste allows the issue of collection frequencies, vehicles, containers, and logistics to be reviewed across all the waste streams. This is why it must be seen as an integrated rather than an ‘add-on’ service.

Operators in general think that sorting food waste leads to higher costs of the overall collection scheme. We have therefore considered it useful to analyse main systems for source separation currently in operation, and to make a comparative cost-assessment.

7.2 The Correct Parameters for Cost Assessment

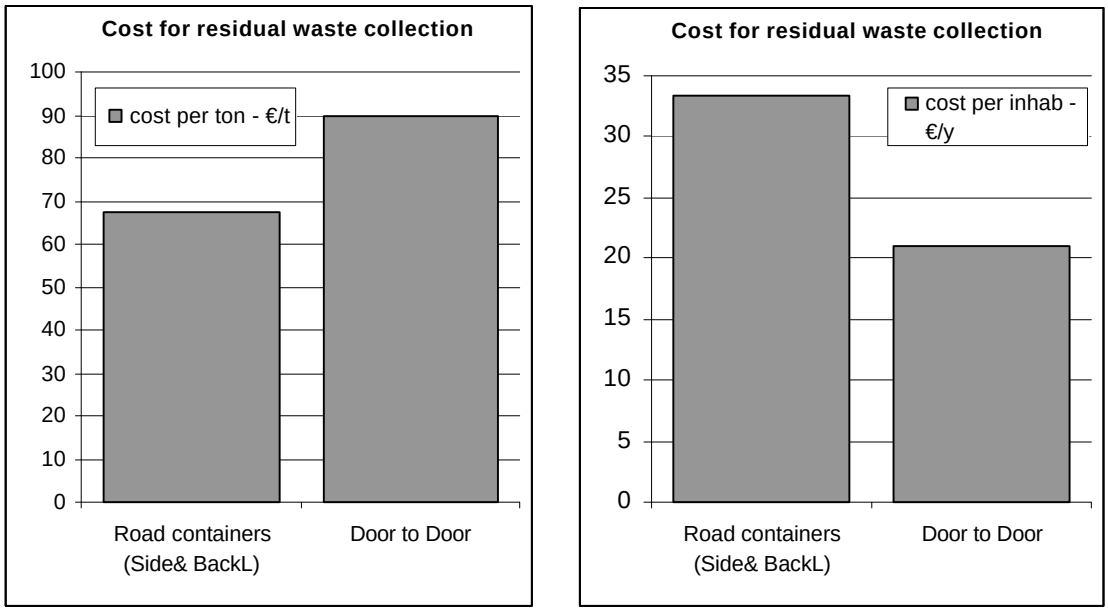
Cost analyses carried out so far across Europe have traditionally focused on **costs *per kilogram (*or *per tonne) for a single waste stream collected***. However, there is evidence that this distorts the true picture, because *the greater the quantity of waste collected, the lower the costs of the collection service per kilogram*. This distortion makes the cost of refuse collection appear low

where there are no separate collection schemes in place, and obscures some important outcomes of integrated source separation and waste management:

- the much lower delivery of industrial waste to the MSW collection route where large-volume road containers are replaced by kerbside collection with low-volume bins and bags
- the effect of home composting programmes on the overall reduction of organic waste collected, etc.; and
- the reduction of total waste delivered as a consequence of effective waste reduction policies, such as the application of PAYT schemes.

In summary, one could say that 'the more the waste collected the lower the costs of the collection service per kilo'. Moreover, it has to be stressed that the cost of the system (collection plus transport) is not paid for by the Municipality considering the amount of the waste collected, but considering the general operational scheme (the number and frequency of collection rounds, the number of workers, vehicles, pick-up points, etc). It is therefore incorrect to express the cost of this service per unit mass, and we shall evaluate it in **cost 'per person'**, i.e. in **€/inhab.year (**or **€/household.year)**. This allows us to compare the actual cost-competitiveness of different systems (in parallel, of course, to their effectiveness in terms of quantity and quality of the waste materials recycled). The different perspectives, and conclusios to be drawn from considering these two parameters (cost/kg and cost/inhab) are illustrated through reference to Figure 14, depicting common outcomes in Italy. The different response of the parameter in €/t is related to the amount of residual waste collected. It is about 235 kg/inhab per year in kerbside collection (also termed collection at the "doorstep" or "Door-to-door", DtD); in the case of collection through road containers, much higher amounts of residual waste are found, typically about 460 kg/inhab per year.

Figure 14: Collection cost for residual waste - medium values



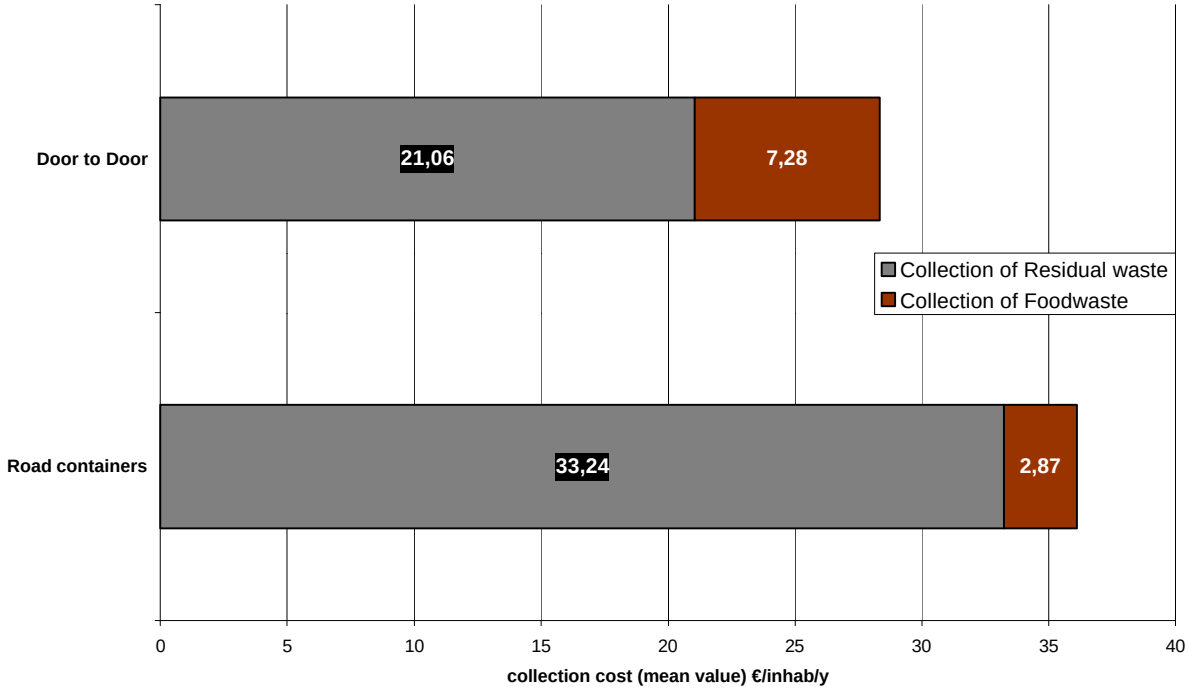
Source: mean-cost for different collection systems for residual waste are compared; data refer to a survey recently performed by Federambiente, the Italian Association of Public contractors [Federambiente – 2003].

Furthermore, the evaluation of the ***cost for a single waste flow does not allow one to assess the potential advantages of collection systems for other materials***, especially following from "operational integration". The collection of food waste – above all when it shows high captures - allows important changes in the overall collection system, by reducing, for example, the frequencies of collection for residual waste (or residual waste). This permits a fair comparison of the competitiveness of different systems (in terms of cost, quantity and quality of materials recycled). Again this can be considered by way of example in Figure 15, which shows the sum of costs regarding door-to door collection for residual & food waste to be highly competitive with traditional collection schemes, performed using road-containers. A further key element we may derive from is that collection of food waste at the doorstep is more expensive (given the higher number of pick-up points) than collection by means of road containers; but that this leads to a significant reduction in the cost of collection of residual waste, which leads, in turn, to a reduction in the cost of collection of waste in the aggregate.

We may therefore say that collection at the doorstep may be made cost-competitive. Moreover, the lower capture of residual waste reduces also the cost/inhabitant for disposal of waste,

though allowance has to be made for the biological treatment of the segregated biowaste. In this respect, it should be mentioned that existing legislation in Slovakia, as well as full implementation of the Landfill Directive, is likely to increase the costs of dealing with residual waste.

Figure 15: Integrating collection schemes for food &residual waste; cost in €/ inhab/year

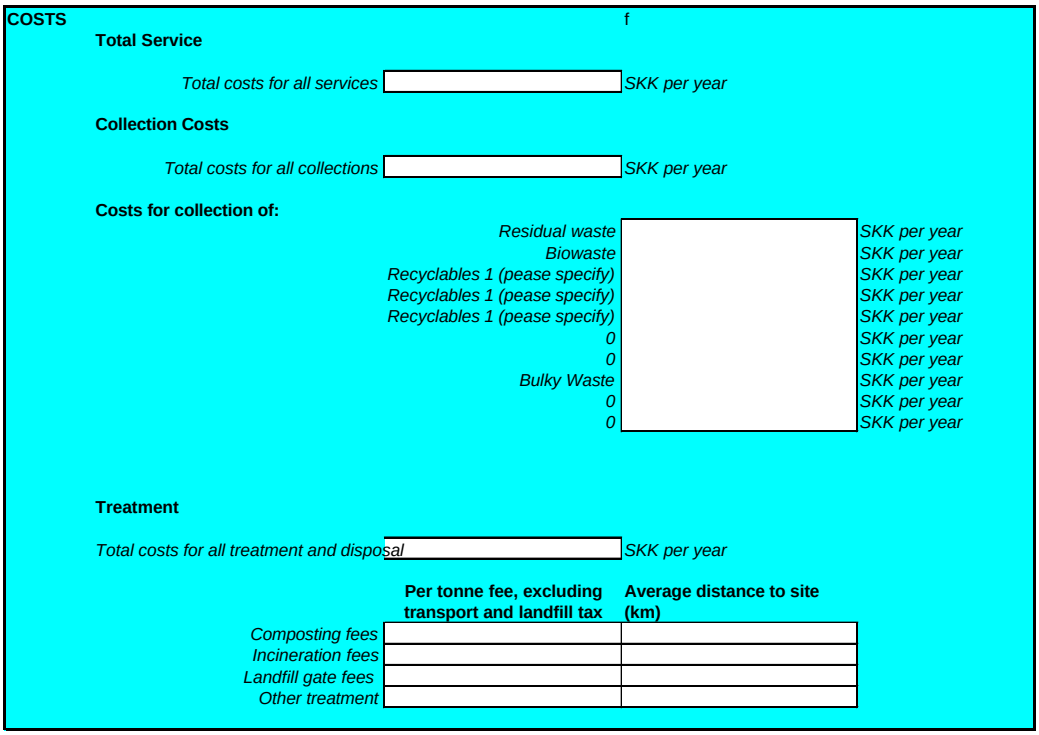


In order to deepen views on optimisation of the collection step, it is also *advisable to* ***split the cost for collection from those regarding treatment and disposal options***, which often represent "external condition" and gate fees that Municipalities have to pay with no possibility to influence them. Generally a cost- analysis for waste management should include the details outlined in Figure 16.

7.3 Key-points to Optimise Collection Schemes for Food Waste

Designing a collection scheme that clearly distinguishes between food waste and garden waste, according to their bulk density and production rates in each season of the year, determines specific operating advantages. We will therefore consider briefly some specific details introduced before and summed up in Table 25.

Figure 16: Outline of Key Parameters Required for Cost Assessment



COSTS		f
Total Service		
Total costs for all services		*SKK per year*
Collection Costs		
Total costs for all collections		*SKK per year*
Costs for collection of:		
Residual waste		*SKK per year*
Biowaste		*SKK per year*
Recyclables 1 (pease specify)		*SKK per year*
Recyclables 1 (pease specify)		*SKK per year*
Recyclables 1 (pease specify)		*SKK per year*
0		*SKK per year*
0		*SKK per year*
Bulky Waste		*SKK per year*
0		*SKK per year*
0		*SKK per year*
Treatment		
Total costs for all treatment and disposal		*SKK per year*

	Per tonne fee, excluding transport and landfill tax	Average distance to site (km)
Composting fees		
Incineration fees		
Landfill gate fees		
Other treatment		

Table 25: Key Tools for Management of Kitchen Waste Collections in Integrated Systems

Tool	Details	Applies where…..
Reduction of the frequency for collection of "Restwaste"	**Effective systems to collect biowaste make its percentage in the "Restwaste" fall down to 15 % and less..**	**…frequent collection rounds are under use (warmer climates)**
Use of bulk lorries instead of packer trucks	**Bulk density of food waste is much higher (0.7kg/dm3) than that of yard waste**	**…tools for collection of food waste prevent deliveries of yard waste**
Reducing/avoiding Washing rounds	**Making the system comfortable promotes self-management of receptacles**	**… watertight bags are combined with collection at the doorstep**

7.3.1 Own-management of Buckets and Bins

Door to door collection schemes request that households and activities are made responsible for the maintenance and cleaning of the receptacles (buckets, bins, etc) assigned to them. This can be achieved by providing each household/producer with specific tools such as bags that can be used to easily manage the more putrescible and critical fraction of waste (i.e foodwaste).

Avoiding or reducing the number of washing rounds can have a significant effect on cost savings.

7.3.2 Hand-loading Versus Mechanical Loading

The introduction of transparent bags for residual waste and small buckets (up to 30 lt) for foodwaste collected at semi-detached and detached houses (with gardens) facilitates a high rate of pick-ups by the collection team relative to schemes adopting wheeled bins and road-containers (which need a mechanical lifting device). A rough comparison of pick-up rates and specific needs on manual or mechanical emptying is shown in the following table.

Hand loading is fully compatible given the low weight of food waste included in small buckets, when garden waste is not collected with it. A weekly collection of food waste should imply a weight of food waste from a family with 3 persons, and considering a capture of 200 grams/inhabitant a day, of around 4 to 4.5 kg.

Equipping the collection vehicles for food waste both with a mechanical device and a manual emptying window, allows collection teams to pick up during the same collection round buckets (with hand pick-up) and larger bins (with a mechanical lifting device). Wheeled bins are used at high-rise buildings, where one wheeled bin serves up to 15-20 families (hence cutting the specific pick-up time in seconds per household), and for large producers of kitchen waste such as canteens, restaurants, etc.

The following tables summarise the different features of the collection tools described for:

- Residual waste collection (see chapter 6.4) - Table 27
- Foodwaste collection (see chapter 6.1) - Table 28

Table 26: Food waste collection –key features of different collection tools

Buckets	Trolley bins	Road container
volume: 10 to 30 l	volume: 80 - 240 l	volume: 700 - 1100 l
hand-loaded	mechanically loaded	mechanically loaded
specific loading time: 12” - 30”	specific loading time : 2’ - 4’	specific loading time : 2’ - 4’

Table 27: Tools for residual waste collection (Door to Door) and suitable vehicles

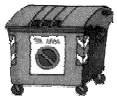
TOOLS		VEHICLES		
	Description	**Compacting vehicle (side-loader)**	**Compacting vehicle (rear loader)**	**Open, non-compacting vehicle**
	Sacks 30-80 l		Yes	Yes
	Bin 80 - 100 l		Yes	Yes
	Wheel –bin 80 - 360 l		Yes	(Yes)
	Container 600-1700 lt	Yes	Yes	

Table 28: Tools for food waste collection (Door to Door) and suitable vehicles

TOOLS		VEHICLES		
	Description	**Compacting vehicle (side-loader)**	**Compacting vehicle (rear loader)**	**Open, non-compacting vehicle**
	Buckets (& bags) 20- 40 l			Yes
	Wheel bins (&liners) 120-240 l		Yes	Yes

7.3.3 Choosing a Varied Fleet of Collection Vehicles

Collection vehicles should be chosen to suit the features of single waste materials, mainly their bulk density. Food waste on its own has a high bulk density (0,6 to 0,7 kg/litre). It does not need compaction. Instead it can be collected and hauled by means of small lorries (see pictures in Figure 17). This does not apply to schemes where food waste gets collected along with yard waste (whose bulk density ranges from 0.15 to 0.30 kg/litre). The use of small bulk lorries is suitable only when schemes effectively prevent the delivery of garden waste along with food waste. This is one of the reasons for limiting the size of the containers supplied to single households. This very important opportunity is unfortunately neglected in schemes based on joint collection of food and yard waste, as e.g. in most Districts in Central Europe and North America, as houses with gardens are usually provided with a large wheeled bin (80 to 240 litres). Food waste is mixed with a very high percentage of garden waste and therefore the biowaste has to be collected by compacting vehicles.

The significance of being able to shift to small non compacting vehicles for food waste is one of convenience, cost and environmental impact. A small vehicle can if necessary be operated by a single person and limits congestion. Its investment cost is only a third that of a compacting vehicle (see Table 29) and from an environmental standpoint, while it adds one further vehicle movement, it allows the substitution of a light (in some cases electric) vehicle collecting twice a fortnight for a weekly heavy compactor vehicle (which shifts to a fortnightly schedule).

Table 29: Estimated specific cost for collection vehicles – cost in SKK

	Open, non-compacting vehicle, 5 m^3	Compacting vehicle, Rear loading, 23 m^3
Investment cost	1.200.000	4.150.000
Depreciation cost / year (5-7 years)	238.000	590.800
Running cost (€/h) including depreciation cost, maintenance, fuel, etc and <u>without</u> driver or operator costs	**354**	870

Source: Report 2003 by Municipality Association " Consorzio Owest Milano" – Italy

Figure 17: Vehicles for the door to door collection of food waste

Open vehicle with 1 driver-collector

Hand pick-up of buckets

Emptying of trolley bins by use of lifting device

A picture of foodwaste collected inside transparent bio-bags (made of modified starch)

Electrical vehicle

Downloading to a transfer vehicle for long-distance transport

7.4 Engineering of Collection Schemes (hints)

The cost-competitiveness of schemes switching from traditional collection of mixed waste (e.g. without separate collection of food waste) towards integrated schemes, can be found in many situations where the savings on residual waste collection are used to support food waste collection.

A rough calculation for the engineering cost for weekly collection-schemes of mixed waste, is shown in Table 30. Cost for labour-force (drivers and collectors) are in line with actual costs provided by private sector operators in the Slovak Republic. The cost per day for vehicles includes maintenance, amortisation and fuel cost. The annual cost for the **collection team** is about 378.600 SKK.

Table 30: Cost of a team for mixed waste collected with rear -loading compactor

Mixed waste	**N**	**Cost**	**Collections /month**	**Running cost (Team)**	
		SKK/day	**N**	**SKK/year**	**%**
Driver	1	800	4	38.400	10%
Collector	2	500	4	48.000	13%
Compacting vehicle	1	6087	4	292.186	77%
Open vehicle	0	2475	0	-	0%
				378.586	100%

The integrated scheme assumes a weekly collection for foodwaste and a fortnightly collection for residual waste (hence halving the previous collection frequency of residual waste). A door-to-door collection is in place. Collection of foodwaste is performed by means of buckets and wheeled bins, collection of residual waste is performed by means of transparent bags (eventually placed inside bins). *At this stage optimising factors related to redesigning the collection capacities of the 2 teams are not considered*. The cost for the 2 collection-teams (one for food waste, the other for residual waste) is shown in Table 31; the annual cost for both teams is about 370.500 SKK.

Table 31: Cost of a team for residual waste collection with rear - loading compactor and food waste collection with open non-compacting vehicle

Residual waste	**N**	**Cost**	**Coll/month**	**Running cost**	
		SKK/day	**N**	**SKK/year**	**%**
Driver	1	800	2	19.200	10%
Collector	2	500	2	24.000	13%
Compacting vehicle	1	6087	2	146.093	77%
Open vehicle	0	2475	0	-	0%
				189.293	100%
Food waste	**N**	**Cost**	**Coll/month**	**Running cost**	
		SKK/day	**N**	**SKK/year**	**%**
Driver	1	800	4	38.400	21%
Collector	1	500	4	24.000	13%
Compacting vehicle		6087		-	0%
Open vehicle	1	2475	4	118.810	66%
				181.210	100%

The largest cost factor of the traditional team (Table 30) is due to vehicle cost (77% of the team costs), hence ***integrating foodwaste collection by reducing overall costs implies reducing the specific cost for vehicles***, not for the labour-force! This aspect should be kept in mind, considering the relatively low labour cost in the Slovak Republic, which suggests that labour-intensive collection schemes should be favoured rather than systems which are more capital intense (because of the use of more expensive vehicle technology).

The integrated scheme (Table 32) seems to be cost effective (the integrated scheme for food waste and refuse is 2% cheaper than traditional refuse collection). The team operating weekly with the open vehicle shows an annual cost (181.200 SKK), which is about 50% the cost that would have arisen if using a compacting vehicle (354.600 SKK).

Table 32: Comparison of annual cost for traditional and integrated schemes

Team for	**Frequency (collections per week)**	**Annual cost (SKK)**
Traditional scheme: mixed waste collected with rear - loading compactor	1/ week	378.586
Integrated scheme: residual waste collection with rear - loading compactor and food waste collection with open non-compacting vehicle	Residual waste 1/2 weeks Foodwaste 1/week	370.502

Moreover, as stated before, the use of buckets, besides avoiding high deliveries of yard waste and allowing the use of lorries, makes it also possible to cut the pick-up time for each household at detached houses, and this entails large savings on the overall time taken for the service and on its cost.

This tool for operational optimisation (which tends to be neglected in schemes based on large wheeled "biobins", even at houses with gardens) may of course be widely effective in any type of climate, yielding important savings relative to collection of biowaste with bins even at detached houses (traditional Central European approach).

A further element for cost optimisation is the increase of the open vehicle fleet (satellite-vehicles), operating with 1 person only (both driving and collecting) and using compactors manly as transfer points for satellite vehicles.

7.5 Final Considerations

The cost parameter to evaluate the economic effort regarding different collection schemes for MSW should be based on cost per inhabitant (or household) served.

According to the numbers shown, it is clear that the main mistake made when planning sorting schemes, is the fact that new schemes are often "added" to existing ones, with no effort made for their integration. It is vital – in stark opposition to this view - that the new separate collection scheme is integrated into the established waste management system, e.g. changing frequencies and volumes to collect residual waste, and this can best be done where the collection of food waste yields high captures through a comfortable scheme, namely collection at the doorstep, using specific tools to make it "user friendly" (e.g. watertight bags to be used as a liner for the bucket). The reorganisation also means that the costs of additional services such as rinsing and maintenance of receptacles (e.g. containers, buckets and bins) is largely avoided.

Cheaper vehicles may be adopted to collect food waste (bulk lorries without compaction mechanisms are suitable), due to the high bulk density of food waste when the collection scheme prevents yard waste from being delivered in the same containers. It is furthermore evident that one of main lessons to be learned from these outcomes is that *'the more flexible and varied the fleet of collection trucks, the better it is'*.

We may therefore sum up the following key point for operational optimisation of schemes, to make them cost-effective:

- the collection of food waste can be substituted by home-composting if a major percentage of households in rural areas (i.e more than 60% of families with gardens) participate. To achieve this, adequate promotion and investment in public relations, and the provision of appropriate tools, is necessary;

- the collection of food waste (which calls for an "intensive" scheme to be made user-friendly) has to be kept separated from that of garden waste (which may be collected in a less intensive way)

- hand loading should therefore be made possible, and is the preferred method to reduce pick-up times, and hence, costs at houses with gardens.

- cheap lorries may be used instead of compactor vehicles to transport the food waste, given its high bulk density relative to "biowaste", when this latter includes also garden waste

- washing rounds may be reduced or even avoided, shifting towards own management of buckets, thanks to the use of watertight bags (which also increases captures making the system user-friendly)

- thanks to high captures of an intensive and comfortable collection scheme for food waste, the frequency of collection of residual waste (which implies higher costs for each pick-up, given the need for compacting vehicles and mechanical lifting devices) may be reduced.

8.0 DECENTRALISED COMPOSTING

8.1 Strategic aspects

Decentralized composting is a strategy aimed at composting source-separated kitchen and garden waste in co-operation with farmers (agricultural composting plants = **ACP**). Farmers can also carry out the separate collection of biowaste. Compost as a product is used directly by farmers involved in the strategy. It is mainly applied in rural areas, or in areas with small municipalities.

The rationale for establishing a decentralised composting system in co-operation with farmers can be summarised as follows:

Socio-economic aspects

- Agriculture is a sector under considerable economic pressure. In many cases farmers need an external income in order to cover the costs of an average farm run by one family. On-farm composting provides additional sources of income, enabling the working place to remain entirely on the farm
- In this system, including the collection of organic household and garden waste, 1 full working-place per 650 tons of treated biowaste can be created. At the same time the added value is kept entirely within agriculture
- Most importantly, the collection is done by the farmers themselves. This saves additional expenses which usually have to be considered for an external waste collection company, and makes it highly likely that the collectors will exert control on feedstock quality.
- the composting farmer serves as a means of disseminating the concept of an ecologically sound biowaste recycling and soil management in the region
- There are no marketing problems for the compost. 80 % of the compost is applied on the farmers land
- The connection is made very directly in householders' minds that material once regarded as 'waste' has considerable value as a resource for utilisation in agriculture.

Ecological aspects

- Rising consciousness for problems of soil fertility and the importance of humus management among farmers
- High level of quality management, as farmers have a high interest on good quality compost for their fields
- Sustainable improvement of the humus (organic matter) status, biodiversity, physical properties of soils
- Reducing the soil's susceptibility to erosion
- Increasing resistance against plant diseases
- Substitution of mineral fertilisers and pesticides (in many cases this is a first step towards an organic farming system)
- Improving the infiltration of water (and reducing run-off and potential problems of flooding)

Further important aspects

- Effective short term reduction of residual waste up to 40 % if source separation of biowaste is combined with effective home composting campaigns and separate collection of dry recyclables
- Improving the engagement of the community in the biowaste system due to the decentralised solution. This is based on the removal of anonymity in the system, creating confidence (and a community relationship) in and around the waste management system
- The system, and its results, is clearly visible for the inhabitants of the region. This builds commitment
- Minimum transport distances as the 'recycling' takes place in the region. This lowers the costs (and, consistent with the proximity principle, reduces transport emissions)[12]
- Cost effective 'Low Tech' but environmentally sound solutions

[12] The proximity principle is outlined in the Waste Framework Directive (75/442/EC as amended by 91/156/EC and 96/350/EC). Strictly speaking, the principle applies to 'disposal' only. Art. 5(2) states *'The network [of disposal installations] must also enable waste to be disposed of in one of the nearest appropriate installations, by means of the most appropriate methods and technologies in order to ensure a high level of protection for the environment and public health.'* However, it is accepted that the principle of reducing transport distances is a sound principle for the management of wastes.

- Lowest possible waste fees for the consumer
- The system also supports manure composting, which improves manure quality and reduces problems of nutrient management
- The farmer is acknowledged as a competent partner in organic waste recycling

Hence ACP is a key element in those areas which are suitable for significant enhancements of home composting, and where a decentralised biowaste management is planned.

8.2 Plant Size

The planning of an ACP follows the principle of good agricultural practice related to environmentally sound nutrient (nitrogen) balances. The amount of compost produced should be linked to the available agricultural land for fertilisation. Table 33 shows a calculation-model assuming three different levels of maximum nitrogen supply per ha and year. The Table relates the available land, and maximum fertilisation rate, to the quantity of material which the compost facility should be designed to deal with.

Table 33: Calculation model for land use in Agricultural Composting Plants

Total agricultural area	**(ha)**	**30**		
Max. N supply	(kg N/ha)	170	210	350
Max. N supply 30 ha	(kg N total)	5.100	6.300	10.500
Total N in compost	(kg N / t FM)	10		
Max. amount of compost produced	(t)	510	630	1.050
Max. f.m. compost per ha	(t/ha*y)	17	21	35
Max. **d.m.** compost per ha	(t/ha*y)	11,1	13,7	22,8
Decomposition factor		0,65		
Max. raw material for composting	**(t/y)**	**1.457**	**1.800**	**3.000**

It must be noted that co-operation between neighbouring farms can be considered. In this way the total agricultural land of co-operating, or contracted farms, can be included when the maximum throughput for an ACP is computed.

8.3 The Role of Quality Assurance for an Agricultural Composting System

The success of the agricultural composting movement in Austria is strongly linked to the foundation of an Agricultural composting Associations (ACA). These Associations were the partners in negotiations with the communities, provincial governments and local authorities, as well as the waste management associations of the districts, the Ministry for the Environment, other agricultural interest groups, and the standardisation committees.

The key task is to guarantee a standardised quality level for all elements of the system (technical standard of composting plants and process control, and product certification in close cooperation with all involved parties). On behalf of the ACA, inspections, with sampling for full external compost analyses by an acknowledged laboratory, should take place 1 to 4 times per year, depending on the size and complexity of the composting facility. All obligatory records and documents are checked. These inspections by an external expert cover 2 aspects: *controlling* and *advisory work.*

In Table 34 the main tasks of an ACA in the framework of a comprehensive Quality Management System (QMS) and Quality Assurance System (QAS) are listed.

Table 34: Tasks of an agricultural composting association in the frame work of a systematic decentralised biowaste management and composting system in co-operation with farms

Task	Description
Representation	Political representation (Min. of Environment / Agriculture; Local government) Local Authorities Municipalities and waste management associations Standardisation bodies Other national and international bodies and committees
Internal Contracts	Membership contract including Obligatory participation in regular training courses Regular inspections of QM by ACA on each composting plant Sample taking of final composts Membership fees Counseling Service System for registration and documentation Procedures for appeals, sanctions and suspensions
Minimum standards for composting plants	Minimum requirements for technical equipment, construction and design of open windrow composting plants Minimum requirements and technical guidelines for material management and the entire composting process

Task	Description
	Special guidance for odour management Special guidance for waste water collection, treatment and reuse Standard computer or paper based documentation and records system for all relevant process steps: Receipt control for source materials Set up and composition of initial compost piles Process control (turning, temperature records, watering, screening etc.) Management and disposal of impurities Compost use and marketing
External quality control and certification	Depending on composting capacity 1 to 4 inspections per year Approval of records and documentation system Approval of good practice and QM of composting process Sample taking of final composts Standard contract and tariffs with laboratories Standard reporting and certification sheet for analytical results for contracted laboratories Compliance with permits and other legal requirements and standards Reporting system to local authorities
Others	Database with all relevant data of the ACPs including permits data, quality data of the regular compost analyses, inspection reports and eventual sanctions. Mediation, when problems occur (with neighbours, local authorities etc.) Standard contract and tariffs system with municipalities Support in drafting the technical report and management plan for permits Recommendations for the compost use (legal limitations and options) Standard sheets for product specification and labelling of compost products
Advertisment, training and PR	Leaflets Information events, conferences, seminars Participation in exhibitions and fairs Articles in journals Campaigns in schools …..

The description of 2 examples of decentralised schemes for organic waste management demonstrate best practice of rural and urban separate collection and composting systems. Besides a supplementary income for the farmers, the approach guarantees the utilisation of quality assured compost as a soil improver and organic fertiliser in agriculture in the most effective manner.

8.4 Cooperative Model : The Example of Hermagor Municipality

8.4.1 Rationale for the Scheme

In this example 2 organic farmers co-operate as partners for performing two activities for the municipality of Hermagor, Carinthia (A):

- separate collection of biowaste from households in a rural district with 7,300 inhabitants
- composting of organic waste.

One Farmer is responsible for the weekly collection of biowaste, the other one for the composting.

Though the separate collection system is offered to all households in the district, only 20 % participate in the system. 80 % compost their organic residues on their own property (farms or backyards) through home-comsposting.

The composting plant (4,800 m²; leek-proof basin for process water, open windrow composting, total throughput ~2,400 m^3 y^{-1}) and the collection truck was made available by the community. The windrow turner and tractor belong to the farmers. Due to the fact that investment costs were not calculated the treatment fee (33.€ t^{-1}) is below the Austrian average.

8.4.2 Use of Compost

The contract (between farmers and the municipality) lays down that the municipality stays the owner of the compost produced, and takes back 40% of it, partially for the fertilisation of the municipal greens and partially to distribute it to the citizens in small quantities (free of charge). The rest (60%) is given to the farmers as soil amendment. Any surplus of compost is marketed for land reclamation, or for private gardening.

Figure 18: Separate collection of biowaste and Agricultural composting

	
Collection truck	Typical agricultural composting plant with open windrow composting on an asphalted rotting area.

8.4.3 Main Details and Costs

Table 35 summarises the main information regarding the investment cost for the project and the fees regarding the collection and composting of biowaste. The income gained for the compost sales belongs to the community.

8.5 Cooperative Model : The Graz-District Collaboration with the Farmers' Association

8.5.1 Rationale for the Scheme

The City of Graz (Styria – Austria) together with its suburbs have in place a separate collection system for biowaste covering a population of 356,000 inhabitants. The municipality of Graz and the surrounding municipalities contracted a syndicate of firms, which is responsible for the separate collection and pre-treatment of organic waste. In a central facility 26,000 tonnes of separately collected kitchen and garden waste is screened, shredded, and impurities (plastics, glass and metals) are removed. The remaining material is then mixed and homogenised.

Table 35: Fact sheet – Agricultural Composting Plant – Hermagor

Structural data		
Inhabitants of the city of Hermagor	1,750	
Total inhabitants including rural villages in the district	7,300	
Households	2,716	
Inhabitants with Bio-bins	20 %	
Collection Tour	30 km 63 Bio-bins / week	
Treated material	$m^3\ y^{-1}$	$kg\ Inh^{-1}\ y^{-1}$
Biowaste	276	~ 30
Green waste	2,100	~ 85
Total	2,376	~ 115
Composting Plant	Built on behalf of the Waste management Association	
Investment	152,000 € (~ 10 € t^{-1} 10 $years^{-1}$) 40% financed by public funds	
Size (asphalted area)	4,800 m²	
Machinery Collection truck	belongs to the Municipality	
Windrow turner; Tractor	belongs to the Farmers	
Shredder & screening machine	On demand hired by the WMA	
Fees Collection	26,65 € / hour	
Biowaste	25,07 € / m³ (~ 33 € / t)	
Green Waste	5,23 € / m³ (~ 15 € / t)	
Use of Compost Municipality	~ 40 %	
Organic Farms	~ 60 %	

Figure 19: In vessel mixing and homogenisation facility for compost raw materials (separately collected biowaste) for Agricultural composting Plants

These ready made raw composting batches are transported in trucks to 18 on farm composting plants (ACP). The contracted farmers take in, annually, between 200 t to 3,000 t, following a fixed schedule, and depending on the individual plant capacity. They use open windrow composting and effectively provide the necessary machinery themselves (turning and screening machines etc.).

Figure 20: Delivery of readily pre-treated raw compost to the ACP

8.5.2 Use of Compost

The compost remains the property of the syndicate until the compost batches concerned are certified in fulfilment of the agreed quality requirements of the Austrian Compost Ordinance. after receipt of the laboratory results, the composts passes into the farmers' possession for use on the agricultural land or further marketing. If the quality does not meet the requirements for use on agricultural soils, the syndicate is obliged to take the compost back and takes over the responsibility for further treatment and use.

An external control body, in co-operation with the provincial ACA, carries out 2-4 inspections per year and ACP and takes at least 1 compost sample for certification per year. Both parties provide full documentation and records according to legal requirements (*Compost Ordinance)*.

8.5.3 Main Details and Costs

Again, the treatment fee is comparatively low since receipt control and pre-treatment is shifted to the external partner.

Table 36: Fact sheet – co-operative model of the city of Graz with 18 farmers association

The city of Graz with suburbs	Graz	Suburbs	Total
Inhabitants (Inh)	238,000	118,000	356,000
Households (HH)	106,000	39,400	145,400
HH with Biobin	77 (95) %	41 %	
HH with Home composting	15 %	85 %	
Collected and treated material BIOWASTE tons kg Inh^{-1} y^{-1}	18,000 [73]	4,000 [42]	22,000 [62]
GREEN WASTE tons			4,000
TOTAL tons			26,000
Number of Farms taking over pre-treated material		18	
Input per Farm tons y^{-1}		200 – 3,000	
Composting fee for farmers (2003) **Biowaste**		**31,- € t^{-1}**	
Green waste		11,9 € t^{-1}	

9.0 LIST OF CONTACTS

The following list of contacts regard the best-practise cases described in the text:

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