Managing Biodegradable Household Waste :

What prospects for European Local Authorities?

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Foreword

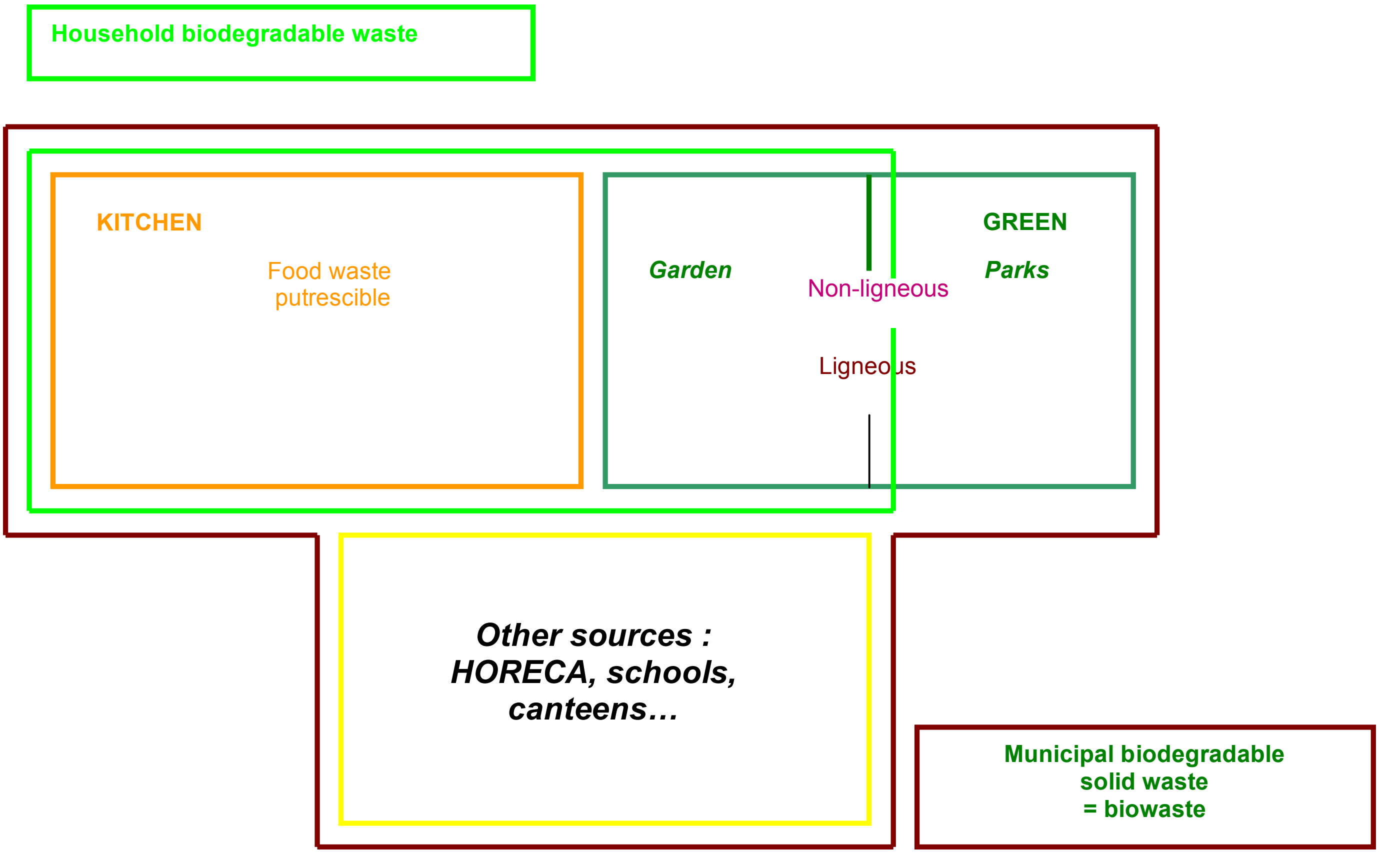
In Brussels, vegetable, fruit and garden waste represent around one third of the household bin. In the field of biowaste management, the Brussels Regional Waste Management Plan focuses on complementary activities on home composting (considered a priority in a Capital city where one third of homes have a garden) and the seasonal collection of green waste in those municipalities with the highest percentage of green spaces. Today, the Region is examining opportunities for developing further selective collection schemes and the treatment options to introduce in future.

These wastes, that produce odours in our bins, are an invaluable source of organic material that forms the core of life, and which our soils are often seriously lacking today. Biodegradable waste management therefore requires us to examine not just collection and treatment systems, but also our consumption patterns, our agricultural production system, our land use management system, etc.

The experiences of cities and regions presented in this report place a value on activity at the local level, and show that it is possible to sustainably manage biodegradable wastes while addressing issues of quality and transparency. In addition, these experiences present a range of partnerships that public authorities can create along the whole of a chain from citizen-separator of wastes to farmer-user of the end-product, including waste management organisations, the private sector, the social economy, etc. In other words, they describe how biodegradable wastes are managed within the context of sustainable development.

The Brussels Region is proud to have held the Presidency of the Association of Cities and Regions for Recycling and Sustainable Resource Management (ACR+) for more than 10 years now, and welcomes with enthusiasm this new contribution from the Association.

Evelyne Huytebroeck
Minister for the Environment and Energy
Government of the Brussels Region


Household biodegradable waste
KITCHEN
Food waste
putrescible
Garden
Non-ligneous
Ligneous
GREEN
Parks
Other sources :
HORECA, schools,
canteens…
Municipal biodegradable
solid waste
= biowaste

Introduction

For 10 years, the objective of the **Association of Cities and Regions for Recycling and sustainable Resource management (ACR+)** has been to help European cities and regions to learn from each other by exchanging information and experiences, while putting the emphasis on the need to develop selective collection and recycling policies to achieve sustainable municipal waste management.

Based on this philosophy, this report seeks:

- To express some of the questions that European local and regional authorities (LRAs) ask (or should ask) in relation to the management of biodegradable household waste;
- To provide food for thought while highlighting the positive attitudes and imagination of European LRAs;
- To strengthen the skills of local and regional actors, while increasing their reflection on the issues.

The illustration opposite aims to clarify the scope of investigation of this report, that is, the biodegradable fraction of the household bin. For more information on the different terms used in this report, we direct you to the glossary of terms and abbreviations as the end of the document.

This report is structured around 8 questions:

1. Why worry about the management of the biodegradable fraction of household waste?
2. What does this fraction consist of?
3. What are the principal biological treatment options for biodegradable waste?
4. How can authorities go from a waste management to a product manufacturing perspective?
5. What are the options for collection ?
6. Why encourage decentralised composting?
7. What are the management costs for biodegradable wastes?
8. What are the potential tools for an integrated biodegradable waste management strategy at local level?

Treatment options (Chapter 3) were deliberately addressed before the issue of the quality of the end-product (Chapter 4) and before posing the question of the importance of selective collection schemes (Chapter 5). It was also a deliberate decision to deal with the composting of household waste on farms within the context of decentralised composting (Chapter 6) rather than as an element of treatment options.

As for its content, you will likely notice that this report touches upon many subjects without being able to consider them to great depth. Although it benefited from the input of numerous experts, this report is necessarily subjective in its writing and in the selection of case studies illustrating LRA experience. Indeed, this first report seeks to be nuanced, completed, and even corrected, by your observations and comments and by discussions that the ACR+ secretariat wishes to pursue on the management of biodegradable municipal waste.

In the spirit of dematerialisation and in the interest of wider dissemination, we have chosen to publish this report in three languages (English, French and Spanish) on CD-ROM and we ask that readers not print it needlessly more than once.

chapter 1

Why worry about the management of biodegradable household waste?

The intrinsic characteristics of biodegradable waste (fractions that are easily contaminated, unstable and sources of nuisance and pollution) call for appropriate management solutions.

1.1. Introduction

Biodegradable wastes, by definition, are wastes that decompose in aerobic or anaerobic conditions.

They are made up of :

- an unstable fraction, which is a source of nuisance in the household bin (odours, percolation, etc) and of pollution in landfills (methane emissions and the subsequent greenhouse effect, groundwater contamination, and contamination of surface waters by leachates)
- a fraction easily contaminated by other substances
- a fraction in which humidity is variable and which can reduce the overall energetic efficiency of the incineration process[1]

Table 1: Calorific values of municipal solid waste and its components[2]

Component	RDF components	Calorific value of waste components (GJ/t)
Paper/card	Y	13.13
Putrescibles		5.9
Plastic	Y	33.5
Textiles	Y	16.11
MSW		10.0
MSW as RDF		6.8

These intrinsic characteristics call for appropriate solutions for their management.

There are different types and sources of biodegradable wastes.

The biodegradable fraction of household waste is only part of biodegradable municipal waste. Nevertheless, in qualitative terms the biodegradable household fraction has an importance that is comparable to other sources of biodegradable waste (industrial, commercial or agricultural).

In addition, it is one of the principal components of the household bin and its management presents an important problem for local authorities.

Indeed, in European countries, depending on local conditions, food and drink habits, climate, and degree of economic development, between 30% and 40% by weight of municipal solid waste (MSW) consists of food and garden waste[3] . This proportion is much larger (up to 80%) in Mediterranean countries.

Table 2: Estimations of different fractions of biodegradable waste in France[4]

	Total arisings (Mt)	Total per person (kg/inh)
Household waste	28 (8 fermentable)	470 (135 fermentable)
Green waste	8 - 12	135 - 200
Urban sewage sludge	10 (0.9 dry material)	165
Organic waste from services	>1.5	25
'Problematic' organic wastes from agricultural industries	± 3	50
Organic wastes from the paper industry	1.8	30
Organic wastes from other industries	0.8	13.5

Unlike the dry fraction of household waste, biodegradable waste management had often been ignored in the past. The Landfill Directive, 1999/33/EC, by requiring progressive reduction of the quantities of biowaste to be landfilled (see point 1.2.), poses the most immediate and significant challenge.

In addition to the pressure from this European law, the sustainable management of biodegradable wastes also allows other ecological and economic issues to be addressed.

1.2. Council Directive 1999/31/EC on the landfilling of waste[5]

1.2.1. Objectives and content

Council Directive 1999/31/EC from 16th July 1999 aims:

- to improve the overall operating conditions of landfill sites; and
- to prevent, or reduce as much as possible, the negative environmental impacts of the landfilling of waste

With that view, it notably sets requirements for all classes of landfills, including water control and leachate management, protection of soil and water, and gas control[6].

Directive 1999/31/EC also demands that Member States introduce national strategies that aim to reduce progressively the quantities of biodegradable waste landfilled. In this way, the total quantity (in weight) of biodegradable municipal waste landfilled needs to be reduced respectively to:

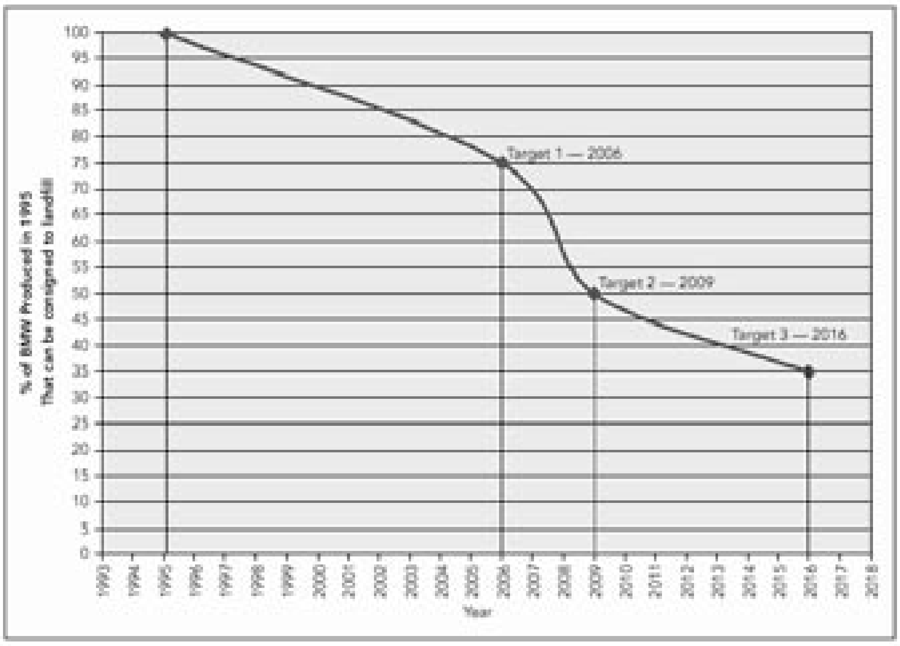
- 75 % in 2006
- 50 % in 2009
- 35 % in 2016

of the total municipal waste produced in 1995 or for the final year before 1995 for which EUROSTAT figures are available.

The Directive states that the aforementioned objectives can be achieved *by recycling, composting, biogas production or materials/energy recovery* (art. 5, 1.). The strategies developed by member states need to be communicated to the European Commission. These targets present a challenge for Local and Regional authorities, who need to adopt strategic approaches at their own level.

Thinking 'waste' – legal constraints
At the European level, the Landfill Directive was created to organise the diversion from landfill of biodegradable waste, with the aim of reducing atmospheric methane emissions, and to improve management conditions at landfills.

Figure 1 : Landfill Directive (1999/31/EC) biodegradable waste reduction targets[7]



1.2.2. Assessment

Two main ideas appear from the first reports examining the implementation and the implications of the Landfill Directive on the management of biodegradable waste in Europe[8].

1) Adopting an integrated approach

The experiences of countries and regions that have succeeded in diverting large quantities of BMW away from landfill[9] strongly suggest that an integrated package of options is needed to achieve high diversion rates, including :

- the availability of widespread and varied separate collection facilities
- a diversity of treatment options
- availability of adequate capacity and markets for the materials collected.

2) Making recovery of biodegradable waste a more economic option

This can be achieved by :

- progressive restrictions or bans on the landfilling of specific waste streams
- the implementation of a taxation system that increases the cost of disposal to a point where it is no longer a financially attractive option.

Article 6 of the Directive requires Member States to adopt measures that ensure that only waste that has been subject to treatment is landfilled. This may not apply to *inert waste for which treatment is not technically feasible, nor to any other waste for which such treatment does not contribute to the objectives of this Directive*[10] .

Inert wastes are defined in Article 2, e) as *waste that does not undergo any significant physical, chemical or biological transformations* . However, the Directive gives no indication of the types of treatment that can render a waste (in this case of biodegradables) inert.

Certain countries, such as Germany and Austria, have established their own criteria (see Point 3.5.1).

A directive on the biological treatment of biodegradable waste was planned within the 6th Environmental Action Programme, being considered as the main response to the commitments of Directive 99/31/EC.This remains a "working document" [12] since the Commission appears to have decided against (temporarily?) the idea of such a Directive. This draft directive defined more precisely the "stabilisation" requirements for biodegradable wastes.

1.3. Opportunities to address environmental concerns

Biodegradable wastes are an important source of organic material (carbon) that contribute to the development of soil structure.

The decomposition of this organic material by composting transforms it into a product similar to humus that can be reintroduced into soils. Its treatment by anaerobic digestion allows the extraction of a renewable energy (biogas), rich in methane.

Seen from this angle, biodegradable wastes need no longer be seen as problematic, rather they are resources from which a value can be extracted. It is also in their proper management that ecological and micro-economic concerns can be addressed.

1.3.1. The sustainable management of soils

The communication published by the European Commission on 16 April 2002 « Towards a Thematic strategy on soil protection »[13] addresses the **impoverishment of organic matter** in arable soils, mainly due to the hyper-specialisation of farms and intensive agriculture patterns.

Composts are a source of organic matter. As **soil conditioners** they can improve water drainage, increase water-holding capacity, improve nutrient-holding capacity, act as a pH buffering agent, help regulate temperature, aid in erosion control, aid air circulation by increasing the void space, aid in disease suppression, slowly release nutrients into the soil, increase cation exchange capacity of sandy soils, help to fight against desertification and floods, etc.

3 Italian Regions (Emilia Romagna, Piemonte and Umbria) subsidise the use of compost by farmers

Following the European regulations on sustainable agriculture and to fight against desertification and promote the sequestration of carbon in soils, the Italian regions Emilia Romagna, Piemonte, and Umbria have already issued provisions for subsidising farmers who use compost in depleted soils.

The Emilia Romagna Region pays €150 -180 / ha to promote the use of compost and the reintroduction of carbon in depleted soils.

The Piemonte Region pays about €220 / ha to use up to 25 tonnes dry matter per ha over a 5-year timeframe, on depleted soils [14].

Man-made compost is also an **alternative to the peat-based compost and to mineral fertilisers**. Peat is a limited resource (with a very long production time), extracted from important natural wildlife sites (wetlands). Peat bogs are precious and unique biotopes with a fundamental role in water regulation.

Though one should keep in mind that the application of organic matter on soils should be not only beneficial, but also safe for crops, humans and the environment (see Chapter 4).

Thinking 'products-resources' – ecological and macro-economic issues

Sustainable soils management
Assessment:

- Depletion of European agricultural soils in organic materials
- Over-exploitation of peat-bogs and the weakening of ecosystems

Compost is an organic improver with many benefits for soils.

Energy and climate change aspects

Assessment :
- Emissions of green-house gas (GHG)
- Using up of fossil fuel energy resources

Biological treatments emit lower levels of GHG. Compost offers the opportunity of locking organic carbon into soils. Anaerobic digestion can increase the value of biomass by turning it into biogas, a renewable energy resource.

1.3.2. Energy issues and climate change

Since the potential greenhouse effect of 1 tonne of methane is equivalent to that of 21 tonnes of CO2, it is estimated that **landfill sites contribute to more than 30% of the global anthropogenic emissions of methane to the atmosphere**[15], Globally, waste management contributed to about 3.1% of the total GHG emissions in Europe in 2000[16].

In signing the Kyoto Protocol, the European Union committed itself to reduce by 8% by 2010 its greenhouse gases emissions according to 1990 levels and, consequently, to develop a strategy for reducing greenhouse gas emissions by encouraging the use of renewable energies.

Some studies[17] show a **real interest of biological treatments from the climate change perspective**. An AEA Technology study, carried out in 2001 for the European Commission's DG Environment, assessed the climate change impacts of different overall strategies for municipal solid waste management[18]. It showed that "(...) *overall, source segregation of municipal solid waste followed by recycling (for paper, metals, textiles and plastics) and composting/anaerobic digestion (for putrescible wastes) gives the lowest net flux of greenhouse gases, compared with other options for the treatment of bulk MWS. In comparison with landfilling untreated waste, composting/AD of putrescible waste and recycling of paper produce the overall greatest reduction in net flux of greenhouse gases*".

Compost and other organic fertilisers contain an element of nitrogen, phosphorus and potassium. Their concentration is quite low, so that they cannot completely **substitute mineral fertilisers**, but they can contribute to increase their efficiency so as to reduce their use and save the fossil energy and components used in their production. Consequently, they also contribute to the reduction of CO2 emissions and other greenhouse gases linked to their production and application.

Organic matter in soils might also play a central role in mitigating global warming : over time, organic fertilisation assists in the build-up of carbon in soil, and this could prove to be a powerful sink of sequestered carbon. Organic matter in soil would allow the sequestration of carbon up to 2 gigatons per year, while anthropogenic carbon emitted to the atmosphere amounts to 8 gigatons per year. It has been calculated that an increase of 0.15% of organic carbon in Italian arable soils would lock the same amount of carbon in soils that is currently released into the atmosphere in one year through the use of fossil fuels[19] .

The European Climate Change Programme COM(2001)580 is examining the impacts and benefits of treating and using biowastes, and the potential use of compost as a "carbon sink" to lock carbon in the soil[20] .

Last but not least, the biodegradable fraction of municipal waste clearly consists of biomass, a source of renewable energy. Its treatment by anaerobic digestion in view of producing a **biogas** (a substitution fuel) addresses the overall objective of generating 12% of our gross internal energy using **renewable energies** by 2010, with an indicative portion of 22.1% for electricity [21].

Further reading:

Biowaste and climate change: a strategic assessment of composting; Favoino, E. and Hogg, D. 2002.

1.4. Opportunities for economically optimising municipal waste management

Thinking about the biodegradable fraction also offers the opportunity to review the management of municipal waste on a social level, particularly in optimising the service on an economic level.

Today, landfill costs are increasing in relation to the implementation of the Landfill Directive and the standardisation of disposal. Incineration, in fulfilling requirements of the Incineration Directive [22], is also an increasing expensive type of treatment. Consequently, there is a powerful economic incentive for considering how to manage biodegradable wastes which does not necessarily favour landfilling or incineration, but which constitutes a convincing argument in favour of composting and recycling.

In addition to these developments, the selective collection of municipal waste has evolved in Europe and offers LRAs the opportunity to "re-think" :

- their selective collection schemes (perhaps modernising the equipment)
- the underlying economic incentives for involving citizens (and thus the taxation and financing system).

This report (especially Chapter 7) addresses the economic dimension of organic waste management and presents case studies highlighting notably that separate collection can sometimes be proven economically viable in itself.

General policy documents:

- Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste; Official Journal L 182 , 16/07/1999
- Working document "Biological Treatment of Biowaste", 2nd draft, DG ENV. A.2/LM/biowaste/2nd draft, Brussels, 12 February 2001
- Biodegradable municipal waste management in Europe, Part 1: Strategies and instruments, EEA, January 2002
- Communication from the Commission to the Council, the European Parliament, the Economic and Social Committee and the Committee of the Regions "Towards a Thematic Strategy for a Soil Protection", COM (2002) 179 final
- Draft discussion document for the ad hoc meeting on biowastes and sludges, 15-16 January 2004, Brussels, DG ENV.A.2/LM
- Report from the Commission to the Council and the European Parliament on the national strategies for the reduction of biodegradable waste going to landfills pursuant to Article 5 (1) of Directive 1999/31/EC on the landfill of waste (COM (2005) 105 final), SEC (2005) 404
- Commission staff working document, Annex to the report from the Commission to the Council and the European Parliament on the national strategies for the reduction of biodegradable waste going to landfills pursuant to article 5 (1) of Directive 1999/31/EC on the landfill of waste (COM (2005) 105 final), SEC (2005) 404

chapter 2

The household biowaste fraction

A good knowledge of the waste streams to be managed is one of the corner stones of sustainable biowaste management.

The composition of biowaste in the household bin generally varies according to a range of factors including geographical location, season, the urban or rural character of the area, type of settlements, standard of living, cultural and food and drink habits, etc. The design of collection schemes and the level of promotion of home composting will equally have an influence.

2.1. Proportion

Depending on the local conditions mentioned above, municipal solid waste is made up of between 22% (UK) and 49% (Greece) of food and garden waste[23] .

Barth (2000) suggests an EU average figure of 32% (see Table below).

Table 3 : The organic fraction of municipal solid waste[24]

Country	Percentage organic material (%) (year)	
Austria	29	(1991)
Belgium	48 Flanders	(1996)
Denmark	37	(1994)
Finland	35	(1998)
France	29	(1993)
Germany	32	(1992)
Greece	49	(1987/1993)
Ireland	29	(1995)
Ital	32 - 35	(1999)
Luxembourg	44	(1994)
Netherlands	46	(1995)
Portugal	35	(1996)
Spain	44	(1996)
Sweden	40	(1996)
UK	22	(1997)
EU Average	**32**	

The biodegradable fraction is one of the major elements of the household bin and in themselves present an important issue for local authorities.

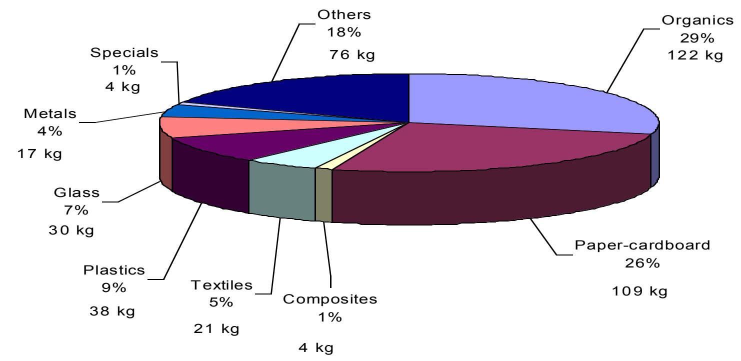
Its sound management should necessarily be based upon an in-depth characterisation analysis in the area concerned, in terms of quantity and quality without forgetting seasonal variations.

The real nature of household biodegradable waste is complex. It exceeds:

- National statistical categories
- « North v South » differences
- « urban v rural » differences
- « kitchen/fermentable waste v garden waste » distinctions.

A 1998 ACR+ survey of around 40 European cities[25] concluded that biodegradable waste represented nearly 29% of all household waste, which corresponded to an average waste generation of 122 kg/person/year[26] .

Figure 2 Average composition of household waste -% by weight (ACR+, 2000)



This illustration confirms that of all fractions of the waste stream, biodegradables are usually the largest one, and that their separate collection and treatment can remove potentially large quantities of material from landfilling or other treatment options.

Beyond, if we consider that key fractions of biodegradable municipal waste include not only kitchen and garden waste but also paper, card and wood, we can easily achieve a proportion of nearly 60%.

However, European or national figures are not always meaningful given all the parameters affecting composition at local levels [27].

2.2. Geographical features

It is likely that green waste makes up an important part of biodegradable waste in northern and central Europe, where these have been collected for some time as municipal waste. This can help to explain some elevated percentages of biodegradable municipal waste that have been communicated by Belgium, Luxembourg and the Netherlands (see Table 3 below).

These countries often designate biodegradable municipal waste as “VFG” (that is, wastes from vegetables, fruits and gardens, in the Belgian Flanders Region and in the Netherlands) or as “Bioabfall” (in Germany). The selective collection schemes they have developed do not generally include the capture of the most fermentable fraction, that is, meat and fish and certain other kitchen products[28].

In Mediterranean areas, high percentages for fermentable waste can be explained by :

- a large use of vegetables and fruits in the daily diet and in the preparation of meals;
- the effect of tourism generating waste from meals; and
- the lower presence of packaging because of a less wealthy economy, and the lower use of pre-cooked or frozen products[29] .

In Italy, for instance, the contribution of food waste alone by door-to-door segregated systems accounts for 60 to 90kg per inhabitant per year. While, depending on urbanisation and the development of home composting, green waste collected through specific systems ranges between 30 to 150kg per inhabitant per year[30].

In North-African countries, organic waste may represent up to 80% of municipal waste.

2.3. Composition

The organic fraction of household waste is composed of :

- a **fermentable fraction** commonly called "kitchen waste",including :
  - what is covered by "VFG-waste" (vegetable, fruit, garden) :
    - kitchen waste (like peels, left-overs, residues from vegetable and fruit, tea bags, eggshells, etc.)
    - a slightly ligneous fraction of garden waste : dead leaves, lawn cuttings, hedge and shrubs trimmings, etc.
  - meat and fish residues that are not included in biowaste collections because of their high level of putrescibility and high salt content.
- a "**green fraction**" often called "green, yard or garden waste" which is made of the ligneous fraction of garden waste, such as tree pruning, dead branches, tree trunks, etc.

Paper is also part of the biodegradable fraction. It is commonly felt that paper recycling is a better option than the application of biological treatment[31], but depending on the local conditions and the existing infrastructure and outlets for paper recycling, paper and cardboard waste may sometimes serve as a valuable source of carbon to allow the composting of food waste.

Elsewhere, kitchen towels, paper napkins and tablecloths, or certain papers that have been soiled by food or that are not acceptable to the paper recycling industry, can be treated by AD or composting.

Table 4: Relevant municipal solid wastes defined in the European waste catalogue [32]

Description	EU code	Notes
Kitchen and canteen waste (food waste)	20 01 08	From households, restaurants, canteens, bars, coffee-shops, hospital and school canteens, etc.
Wood waste	20 01 38	Not containing dangerous substances No furniture and bulky household waste
Garden and park waste (yard waste)	20 02 01	From private gardens, and public parks and areas, etc.
Waste from public markets	20 03 02	Only biodegradable materials equivalent to codes 20 01 08 and 20 02 01

Traditionally, the organic fraction of the household bin consists of *2 main streams* whose respective characteristics justify distinct management systems:
- Kitchen waste
- Garden waste.

If we add some *specific streams:*

- paper/card
- biodegradable
- plastics
- nappies

These components are more or less rapidly biodegradable. Food waste is putrescible and so rapidly degrades, whereas leaves and egg shells contain more carbon and therefore degrade more slowly. In Chapter 3, we explain that composting requires a good balance between the ligneous and putrescible fractions.

2.3.1. Food waste

The average quantity of food waste from households will vary between 200 and 300 grams / person / day, depending again on standard of living and general living and cooking behaviour[33].

2.3.2. Garden waste

In normal weather and cropping conditions, lawn mowing from both public and private areas can yield from 2 to 6 kg / year of grass clippings per square meter. These figures can be roughly doubled when taking into account pruning and leaves[34]. An average figure for garden waste could be 3 kg / m^2 [35].

2.3.3. Some specific biowaste flows

Some items in the municipal waste management stream have a complex composition, with variable levels of degradability.

2.3.3.1. Biodegradable plastics

The European standard EN 13432:2000 was adopted at the EU level as an ancillary measure to the Packaging Directive[36]. It specifies requirements and procedures to determine the degradation potential, in aerobic and anaerobic conditions, of packaging and packaging materials, according to four criteria: biodegradability, disintegration during biological treatment, the effect on the biological treatment process, and the effect on the quality of the resulting compost. EN 13342 requires 90% biological degradation within 6 months.

One of the main economic drivers for the use of biodegradable packaging materials could be a more favourable waste management fee applied by "Green Dot" companies to the producers.

In the **Netherlands**, bioplastics (marked with the "plant germ" logo) have been collected and treated along with garden, fruit and vegetable waste since 1stMay 2004. The Afval Overleg Orgaan (the Dutch waste management council including municipality representatives) acknowledged that the use of bioplastics is better for the environment than other plastics, and that they have no adverse effects on compost quality. Though careful attention will be paid to the introduction of bioplastics in green bins, in order that they do not lead to contamination with classic plastic packaging (thereby adding extra costs for municipalities)[37] .

Including biodegradable plastics in biowaste selective collection : positive experiment in Kassel (Germany)

The City of Kassel (200,000 inhabitants) ran a pilot project from May 2001 to December 2002 which aimed to clarify whether :

1. consumers would separate labelled, compostable packaging materials made from biodegradable polymers (BDP), without confusing these with conventional plastic packaging;
2. BDP packaging items would interfere with the composting process;
3. the resulting compost would be safe for use in agriculture.

Outcomes of the pilot appeared to be satisfactory.

1. The levels of contamination in the organic waste collected by Kassel's collection facilities did not change significantly and a slight reduction of the impurity percentage was even detected, which could be explained by intensive communication during the project phase. Only small proportions of biodegradable polymers were found in the MSW, and the pilot project showed that consumers can distinguish between conventional plastic packaging and their substitutes made from biopolymers, when these are clearly labelled.
2. The processing of BDP in composting facilities is possible, though

it may require some adaptation measures to provide optimal source separation. Manual source separation was for instance affected by the presence of higher amounts of BDP items with simultaneous increases of conventional plastics.
3. A full-scale agricultural test demonstrated that composts made from biowaste mixed with certified biopolymers were of the same quality as conventional composts.

Sources :

Biodegradable Polymers, Back to Nature – Towards Sustainable Development, IBAW, 2002
The Kassel project – Use and recovery of biodegradable polymer packaging, Matthias Klauss and Werner Bidlingmaier

For more information : http://www.modellprojekt-kassel.de

Compliant biodegradable plastic bags have already shown to be a useful tool in optimising kerbside collection of biowaste (this topic is addressed further in Chapter 5).

2.3.3.2. Some "troublesome" biowaste : nappies
During its time in nappies (around 2.5 years), a baby uses around 6,000 nappies or about 1.5 tonnes of disposables[38]. In general, disposable nappies are thrown out with residual waste, making up a considerable proportion of a household bin. In the Flanders Region[39] , disposables make up 10% of total municipal waste. This fraction is usually incinerated.

Disposable nappies or sanitary towels contain a proportion of compostable materials.

Some European municipalities have chosen to collect these wastes separately for recycling. For example, more than 100 municipalities in the Netherlands recycle their nappies and incontinence products through a company with a recycling plant near Arnhem[40] . The process shreds the materials which are then sent to a pulper. The pulping process begins the separation of the components and prepares them for chemical treatment. The plastics are removed and pelletised, making a marketable product. The pulp stream is screened to remove plastics and then is chemically treated to deactivate the super-absorbent polymers (SAPs) and to make it possible to separate these from the fibre element. The SAPs element can be collected and reactivated for reuse. The fibres are mechanically washed, cleaned and screened, producing a marketable fibre.

Other authorities try to focus more on prevention, and so introduce reusable nappy schemes for their citizens and/or encourage their use.

Municipality of Merelbeke (Flemish Region, B) : promotion of cotton nappies

Today, pre-formed cotton nappies can be found which are often more easy to use than disposables, and above all they cost less (estimated savings of €620 over a period of 2.5 years) and are better for the environment.

The Municipality of Merelbeke decided to support the purchase of reusables through a subsidy : all the families with children between 0 and 3 years and who can prove the purchase of a minimum of €200 for reusables are eligible for a subsidy of €30. For those families wanting to test reusables by renting a pack, a subsidy of one-tenth of the price was available.

For more information : Gemeente van Merelbeke, Dienst Afvalbeheer,
tel. +32 9 362 79 63, e-mail : afvalbeheer@merelbeke.gov.be

Further reading :

Onderzoek naar de productie, selectieve inzameling en verwerking van incontinentieafval in het Vlaamse Gewest, OVAM, November 2003.

chapter 3

Main options for the biological treatment of household biowaste

Treatment options for biodegradable municipal waste range from biological treatment like composting and anaerobic digestion, to more complicated thermal treatment such as gasification and pyrolysis.

Points 3.1 to 3.3 examine the most common biological treatment options for biodegradable wastes in Europe today, that is, composting and anaerobic digestion.

The application of biological treatment processes can only apply to biodegradable waste. Hence the necessity :

- to collect these wastes at source; or
- to apply mechanical biological treatment (MBT) methods on the collected fraction, so that the biodegradable part can be extracted and treated.

In line with the approach taken in this report of promoting quality end-products (see Chapter 4), Point 3.4 only considers the advantages of MBT in treating residual waste.

2 major biological treatment types can be identified for organic waste:

- composting
- anaerobic digestion.

3.1. Composting

3.1.1. Principles

At its most basic, all that composting requires is biodegradable waste, moisture and air. The material naturally decomposes under the effect of micro-organisms to a point where soil conditioner is produced that is comparable to humus. Due to the temperature generated by the process (60°C and higher), harmful micro-organisms and undesirable seeds and weeds or roots are destroyed. The product is stabilised such that any subsequent changes to its texture and its composition will be extremely slow.

The compost is then said to be mature.

Certain essential factors must be considered to have an efficient composting process:

- aeration (in order to avoid anaerobic digestion);
- temperature (in order to kill any unwanted matter without killing all microbiological activity);
- humidity rate (the optimal level appears to range between 50 and 65% of the weight [41]);
- availability of a growing media that provides living organisms the energy required for their development and reproduction (this is measured in relation to carbon/nitrogen).

Composting: a relatively simple and basic technology that is not very expensive.

Compost is both a soil improver and a growing media which can have various applications in open fields, horticulture, floriculture, home gardening, landscaping activities, etc.

It is commonly accepted that good quality compost must :

- have undergone a sufficient maturation process;
- not contain any toxic elements like root pathogens, heavy metals, etc.
- not contain (or very few) undesirable elements like plastics, rubber, metal, glass, or stone fragments, which besides their negative perception by users, can cause aesthetic damage to the environment and increase operational costs.

Key elements :

- A good balance between carbonic and nitrogenic materials.
- Maintaining temperature while keeping an eye on oxygenation.

Despite higher costs and a more complex technology, in-vessel composting presents a series of benefits.

3.1.2. Which technology to choose?

Different composting techniques exist, but the basic requirement is that the temperature be maintained while keeping oxygen circulating.

Composting can be centralised or decentralised; decentralised composting (home, community and on-site composting) is dealt with in more detail in Chapter 6.

For centralised composting, we describe briefly two techniques that appear to be the most commonly used to date: windrow and in-vessel.

3.1.2.1. Windrow composting

Windrow composting is the *composting of biowaste placed in elongated heaps which are periodically turned by mechanical means in order to increase the porosity of the heap and increase the homogeneity of the waste*[42].

Turning exposes fresh surfaces to the degradation process.

Windrow composting can be done in the open air, under cover or in an enclosed building.

It is a very simple process to manage. Though it requires :

- a large land area
- a hard surface (concrete or asphalt)
- a turning frequency adapted to the biological activity of the pile.

In addition, the process takes a long time and, except when done in a closed building, the turning of the degrading organic matter presents the risk of producing odours for the neighbouring area. This is one of the reasons why windrow composting in open air is increasingly reserved for low-level fermentable garden waste. On the other hand, one can see a tendancy to compost food waste and other fermentables in closed buildings or in-vessel, at least for the initial phases of the process.

To avoid the production of odours in the turning process, it is possible to leave the piles static, or to turn them intermittently, guaranteeing their oxygenation by blowing air into the piles or sucking it out. So, we talk about composting on "beds".

3.1.2.2. In-vessel composting

In-vessel composting is the *composting of biowaste in a closed reactor where the composting process is accelerated by an optimised air exchange, water content and temperature control*[43].

The reactors (vessels) can be horizontal units (tunnels), vertical units (towers), rotating drums or agitated reactors.

The methods used to control oxygen supply, temperature and moisture loss are through mechanical agitation and/or forced aeration. Each system offers different methods of material flow and handling, and process automation.

Tunnel composting units are large-scale rectangular vessels using forced aeration systems. They can be filled with loading vehicles or conveyors and may be single- or double-ended for loading and unloading. Most of the time, they are used to process materials in single batches (all in /all out).

Aeration can be achieved by different techniques: slatted floor, perforated pipework or aeration channels. The control of the air entering and circulating in the system allows oxygen and temperature levels to be controlled.

Moisture may be controlled by pumping leachate and/or fresh water and spraying it on the material processed in the tunnel.

Odours gases are usually controlled by passing exhaust air through biofilters.

Despite higher investment costs and its more complicated technical nature, in-vessel composting is an increasingly widespread technology. It is characterised by:

- A better control of odour nuisances since the core of the decomposition process takes place in a totally closed setting. The installation can be equipped with biofilters and put under greater atmospheric pressure to contain the odours.
- A higher compactness of the installation, reducing its visual impact.
- An easy maintenance of the cleanliness of the site.
- Better working conditions for the staff.
- An easier control of the site due to the absence of leachates (due to the absence of water).
- A better control of the system parameters.
- A greater flexibility in relation to the seasonal variations of quantities of waste produced, since each tunnel is autonomous. This characteristic is particularly important in tourist zones.

Greater Authority of the Pays de Lorient (France) : Successful in-vessel composting

The Greater Authority of the Pays de Lorient (190,000 residents) in northwest France introduced a management strategy using a method of closed-tunnel composting, allowing them to compost biodegradable wastes collected selectively, and to stabilise other biodegradable wastes before they were landfilled.

22 tunnels compost mixed waste (57.000 tonnes of 'grey' waste and 8,000 tonnes of crushed bulky waste per year). The wastes are separated by aerolitic and densimetric processes, and metals removed. The 35,000 tonnes of compost produced per year, after 5 weeks of composting, are landfilled. 8 tunnels compost biowaste (16,000 tonnes of waste are received and produce more than 6,400 tonnes of compost per year, taking 3 weeks in the process). These are used in agriculture)

This solution was preferred over anaerobic digestion because of the reduced volume of wastes to be treated. In addition, in France, composted wastes are required to remain a minimum of 3 days at 57°C, and an anaerobic digestion process does not guarantee this requirement.

Selective collection of biowastes
The Pays de Lorient, considers biowastes and green waste as a precious material from which value can be extracted.
The selective collection of biodegradable waste was provided to the whole of the population in December 2002. After one year, the capture rate is 42 kg/person/year. The compost from green waste is treated by private companies and is sold to the farmers in the region. The waste flows are not mixed [44].

Outline general treatment costs (excluding VAT) :

- green waste: €25 per tonne treated
- biowastes : €56 per tonne treated
- residual wastes: €83 per tonne treated, including landfill tax (€332)

A successful strategy
The factors of success of this system are:

- a system of proximity ;
- a system considered acceptable by the population and the local associations thanks to good communication procedures providing information on the technology to the residents, including a visit to a similar installation in the Netherlands before the site was created in the region;
- the direct creation of 100 jobs in the collection and treatment chains.

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3.2. Anaerobic digestion

Anaerobic digestion (AD) processes are quite old technologies [45], but their wider use was prevented due to the development of aerobic treatment and the low costs of coal and petroleum. European countries are now exploring the technologies for three main reasons :

- increasingly stringent environmental and waste management regulations
- "green rate" electricity programmes in some European countries (existing in the Netherlands, Finalnd, Ireland, Norway, Sweden and Switzerland) or "green certificates" (ex. Belgium) promoting renewable energy sources
- higher fossil energies prices.

3.2.1. Definition and Principles

Anaerobic digestion: a process of degradation of organic material in the absence of oxygen.

AD is a process which breaks down organic matter into simpler chemical components without oxygen (that is, under anaerobic conditions). This degradation process is more difficult to reproduce artificially than composting, as it involves different methanogenic bacteria which work at different temperatures, various pH conditions etc.

The outputs of anaerobic digestion are :

- a **digestat**e made up of fibre, which can be post-composted, and liquid residues;
- **biogas** (a mixture of methane, carbon dioxide and water vapour); once purified from hydrogen sulphide, it can be used as a source of energy for the production of heat and electricity.

The process can be best understood if split into 4 stages :

1. **Hydrolysis:** fermentative bacteria transform the insoluble and complex organic matter into soluble molecules such as fatty acids, amino acids and glucose;
2. **Acidogenesis:** an acidogenic bacteria (acid formers) convert the products from the first stage into simple organic and acetic acids, carbon dioxide, alcohols and hydrogen;
3. **Acetogenesis:** acetogenic bacteria transform alcohols and organic acids into acetic acids;
4. **Methanogenesis:** methane is produced by methanogenic bacteria.

Non-organic materials or some organic materials such as lignin remain undigested.

3.2.2. Some parameters of the process

A variety of parameters and practices.

The proper breakdown of organic compounds requires certain conditions:

- **total solid content:** allows the distinction between liquids (feedstock less than 10% total solid content), semi-solids (feedstock with about 15%-20% total solid content) and solids (feedstock with 22%-40% total solid content).
- **temperature :** The higher the temperature, the more effective it is in eliminating pathogens, viruses and seeds. **Thermophilic digesters** (~55°C) might be more efficient (shorter retention times[46] , higher loading rates and gas production, more effective sterilisation) but also more expensive, more sensitive and problematic than **mesophilic digesters** (~35°C). They are likely, in any case, to become more common in the future due to legal requirements for waste, in particular relating to the treatment of animal by-products[47] , to be sanitised.
- **The digestion system can be continuous, semi-continuous or in batch.** Semi-continuous systems aim to optimise digestion and improve control of the process in separating the stages of digestion.
- **retention time :** this is the time needed to achieve the complete degradation of the organic matter. It varies with the process temperature and the composition of the waste.

- **pH :** During digestion, the two processes of acidification (acidic conditions) and methanogenesis (basic conditions) require different pH levels for optimal process control.
- **Carbon to nitrogen ratio :** optimum C:N ratio in anaerobic digesters are between 20 and 30.

3.2.3. Anaerobic digestion : for which purposes ?

AD is capable of treating a wide range of organic waste streams such as sewage sludge; municipal solid waste; organic industrial, commercial and agricultural waste; etc. Sometimes, these different wastes can be treated together, requiring that the content be mixed well enough to be homogeneous.

The higher humidity level of kitchen waste and of canteen, hotels and restaurants, render these wastes particularly suitable to AD.

On the contrary, ligneous elements (green waste in particular) are not often directly degradable by AD (not without resorting to a range of chemical/physical processes that increase treatment costs).

Different types of digesters are available, using different temperatures, mixing equipment, etc. The solid organic content of the materials to be treated will define the type of digester used.

A process well-suited to materials with high humidity.

3.2.4. Pre-treatment requirements

The materials being introduced into the AD process generally need to undergo various types of pre-treatments, in order to mix the contents enough to provide a uniform particle size, to increase humidity levels or to remove undesirable materials.

Pre-treatment processes for municipal solid waste can be quite complex. They consist of separating the non-digestible waste from the biodegradable waste. This can be achieved either by :

- source separation: reducing the contaminants in the feedstock, and producing a better quality digestate;
- mechanical separation: which often leads to a lower quality digestate as it does not seem allow today to achieve the same quality as separation at source, nor to remove all the contaminants, especially regarding the smaller fractions and heavy metals.

This second option is mainly used when source separation is not possible. It can involve:

- manual sorting to remove undesirable materials (large items)
- rotating trommels and screens for removing over-sized items
- hammermill to reduce the size of the waste
- a hydropulper[48]

It is worth noting that bio-mechanical pre-treatments often cause a loss of organic volatile solids in the feedstock content, resulting in a decrease in the production of gas.

ITRADEC – Mons (Belgium) : a leader in the Walloon Region

ITRADEC is an association of 23 municipalities, located in the middle West area of Belgium, with around 462,000 inhabitants. ITRADEC has developed the first anaerobic digestion project for household waste in the Walloon Region. The AD plant has the capacity to treat about 60,000 tonnes of putrescible waste per year. The AD unit currently treats about 530 tonnes of waste per week, or about 28,000 tonnes per year.

Only one of the two digesters is used currently for the anaerobic digestion of organic grey waste. The second one will be dedicated to sorted biowaste (VFG waste)when selective collections are started.

Bio-mechanical treatment:

Grey waste is sorted at the sorting plant (306 tonnes sorted daily) with :

- screening and size reduction of bigger material
- magnetic separation of ferrous metals
- granulometric separation (bigger materials are sent to cement kilns) where they are used as combustibles
- densitometric separation to separate putrescible waste from remaining small inert waste.

Anaerobic digestion process:

1. Dilution of the organic matter (VFG waste) until the total solid content is 35%
2. Heating of the feedstock to 35°C (mesophilic process)
3. Introduction into one of the digesters, where micro-organisms will decompose organic matter over 3 to 4 weeks
4. The digestate then goes through a screw press allowing the extraction of the excess water content. These liquids will be reused for the dilution of new organic matter and the remainder is treated in a sewage sludge treatment plant.
5. The digestate will then undergo 2 extra weeks of complementary maturation (through injection of warm air and windrow turning).

Outlets:

1. compost production : 1 tonne of feedstock produces about 600 kg of compost. 290 tonnes of compost are produced per week – about 15,000 tonnes per year .

The compost is used for :

- landscaping, daily cover of landfill sites, cleaning up of old dump sites
- rehabilitation of industrial sites.

2. biogas production: one tonne of organic material produces 148m^3 of biogas, made up of 60% of methane, therefore the net production of electricity of 235 kwH.

The 82,880m^3 of biogras produced per week are converted into by four gas motors of 535 kW each. The electricity produced allows the AD plant to be completely self-sufficient, and also feeds the sorting centre of ITRADEC. It allows the saving of around 2,500 tonnes of petrol per year. The surplus is sold on the local grid, to be used mainly during the night and at weekends.

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3.2.5. The products of anaerobic digestion

3.2.5.1. Biogas

Biogas produced by AD processes is primarily composed of methane (CH_4) (± 55 %) and carbon dioxide (CO_2) (±45%) with smaller amounts of hydrogen sulphide (H_2S) and ammonia (NH_3) and traces of other gases. The composition of biogas is very different from natural biogas, but is very similar to landfill gas and varies according to waste composition.

Biogas can be used :

- for *heating*
- in combined *heat and power (CHP) units* - the distance between the plant and the gas user must be taken into account because piping costs may be prohibitive.
- as a *fuel for vehicles*. This application requires the same type of engine as those used for natural gas. However, the biogas will have to be upgraded: the methane content needs to be increased to 95% and the gas should then be compressed. Such operations can have high costs, even if upgraded gas is considered to be one of the most environmentally-friendly fuels.

3.1.5.2. Digestate

In order to offer the maximum recovery value to waste, the digestate should have a useful purpose and be sold for a price.

Sometimes, digestate may need to be dried and therefore separated into two fractions :

- the **fibre**, which can be used immediately as a soil conditioner or low grade fertiliser, or with further processing, can produce a better quality compost [49].
- and the **effluent**, containing a large proportion of nutrients. This might be used as a fertiliser while being careful with the application frequency (due to risks of nitrogen leaching into soils). Many AD plants also reuse the effluent in their processes if the ammonia content is not too high (due to the risk of inhibiting the AD process).

Municipality of Lille (F) – how an anaerobic digestion project can power a fleet of 100 city buses

The Municipality of Lille manages 705,000 tonnes per year of municipal waste produced by 1.2 million inhabitants.

In the early 1990s, facing an increase in the production of household waste, the authority decided to adopt a global approach to the management of its municipal waste – ‘throw away less, separate more, treat better’. Launched in 1994, household selective collection involves 550,000 inhabitants who not only separate their waste ‘clean and dry’ but also their biowastes (kitchen and garden wastes). The green wastes (more bulky) are collected by bring system to 6 civic amenity sites.

The wastes are composted at different sites, at times outside the territory of the authority. A plant for the recovery of biowaste will begin operation at the start of 2007, which at the same time will form part of:

- a waste management flow arranged around 2 transfer centres in the north and south of the region and which will transfer waste by water
- an overall delivery of decontamination and rehabilitation of a polluted site
- the authority has decided on anaerobic digestion with post-composting.

Lille Métropole

The plant helps to meet an objective set by the authority to be self-sufficient in managing its wastes, i.e. they want to treat all their wastes within the authority territory. They decided on anaerobic digestion because it is more compact than composting and it allows an extra recovery from the organic material – that of the production of biogas.

The inclusion of post-composting in the treatment process is justified by the composition of the wastes to be treated (a high proportion of garden waste) and the search for a mature end-product. This will also allow the independent management of the excess liquids that result from the methanisation process, the liquids being evaporated in this phase of the treatment.

The composting installation will be able to treat 108,000 tonnes per year.
It will produce around 34,000 tonnes of compost per year and enough methane gas to run a fleet of 100 city buses from a petrol station at a depot that will be contructed near the site. The alternative of producing electricity was not chosen due to the low rate of purchase proposed by Electricity of France.

The Municipality of Lille granted a €54m design/construction contract for its composting plant in August 2003.

It is also associated to the cities of Haarlem (NL) and Stockholm (S) and the Region of Göteborg (S) and to other partners in research and evaluation in response to a European Commission project called « Biofuel Cities ». Called 'Biogasmax' (Biogas Fuel Market Expansion to 2020), the project aims to share experiences on anaerobic digestion of waste and the creation of methane fuel, to provide thoughts on the environmental benefits of fuels derived from wastes, and to promote this type of fuel as a means of achieving a European Directive objective on the substitution of fossil fuels with bio-fuels.

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3.3. Aerobic or anaerobic?

The answer to this question is that it depends on factors relating to the local context, and more precisely on the types of waste to be treated and the local environmental conditions.

3.3.1. Types of waste to be treated

Anaerobic digestion is more appropriate for **waste with very high moisture and fat content** (typical characteristics of kitchen waste). Composting is more efficient for waste with a high lignin content (as methanogenic bacteria are not really able to degrade lignin). So, anaerobic digestion appears more suitable for big cities, where there is relatively little wood and garden waste.

3.3.2. Local environmental conditions

Anaerobic digestion plants can be more capital intensive and difficult to run from a technical point of view than composting plants. The treatment of the effluent resulting from anaerobic digestion can particularly pose problems.

However, they fermentation process takes less ground space, odours are confined to the digesters, and there is more opportunity to control the process. It also allows a higher net reduction of biomass, within a period of only 20 days as opposed to the minimum of 4 weeks required for composting. Finally, AD plants produce a gas which is rich in methane and can be the source of income, as well as a digestate that can be stabilised by composting and used as a fertiliser.

Advantages	
Composting	**Anaerobic Digestion**
• rather simple process and cheap technology (even though there is a growing trend for in-vessel composting plants)	• Reduced space and requirement • Easy emission/odour management • Recovery of energy and fuel (the production of which is sometimes subsidised in some countries)

Some installations combine the advantages of both processes, with a post-composting step after anaerobic digestion. Certain hybrid systems allow the choice between composting and AD according to the type of wastes being received.

In this way, it is possible to get energy recovery together with a good quality soil improver.

Frankfurt am Main (Germany): A successful hybrid system

Since September 1999, the city of Frankfurt am Main has been recycling its biowaste in an innovative waste treatment facility, combining in one plant both AD and composting processes. The plant is located in Frankfurt's Eastern Dock area.

Depending on the characteristics of the waste received, it is possible to choose between the processes or to combine the two, which makes the plant independent from the fluctuations in the composition and the consistency of the material.

Not only does the plant allow the material flow to be controlled, but the biological waste cycle is completely closed and compost, electricity and thermal energy are produced.

Regional situations vary considerably according to:

- Types of waste generated
- Potential outlets for end-products.

The chosen treatment type (composting or anaerobic digestion) will also determine the type of end-products produced.

The choice of one or another treatment option should relate to a given local context, according to economic, environmental and social aspects, while guarding maximum flexibility in relation to possible developments of this context.

The use of biological treatment types will have an impact only on biodegradable waste, where it is necessary to:

- collect biodegradable waste separately at source; or
- collect mixed waste and biomechanically separate the biodegradable waste it.

Mechanical-biological treatment (MBT) is a general term covering a variety of combinations of centralised mechanical separation linked to one or many biological treatment methods, which allow:

- the extraction of biodegradable waste in order to recycle or recover them in the form of refuse-derived fuel (RDF)
- the pre-treatment of biodegradable waste to be landfilled, reducing their mass and stabilising them
- diverting the biodegradable fraction from landfill by:
  - drying for use as RDF
  - producing a 'stablised' organic fraction, with or without biogas.

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3.4. Relevance of the use of biomechanical treatment on the residual fraction

"Mechanical/biological treatment" is defined in the European Commission's Working document [50] "Biological treatment of biowaste" as "*...the treatment of residual municipal waste, unsorted waste or any other biowaste unfit for composting or anaerobic digestion in order to stabilise and reduce the volume of the waste...*'.

Bio-mechanical treatments (MBT) are used principally to reduce by volume and weight and to stabilise the fermentable fraction of MSW before it is landfilled, minimising landfill odours, gas and leachate emissions. In this sense, MBT is a legitimate route for local authorities to pursue in seeking to meet their Landfill Directive targets.

MBT can be used for the recovery of useful materials (such as metals) and for the production of refuse-derived fuels (RDF).

As indicated by their name, MBT cover various types of technologies combining both mechanical and biological processes.

There are 2 broad families of approaches, depending on the initial step taken to deal with the incoming MSW :

- size reduction (by milling or shredding) (= pre-shredding approach)
- separation through a combination of technologies (hand-picking, size and density based techniques, wet/dry separation, use of electric/ magnetic fields, etc.) (= pre-screening approach)

Following the extraction of undesirable materials (e.g. sand) and recyclables (e.g. glass and metals), MBT plants can treat the putrescible fraction of waste by composting, anaerobic digestion or a combination of both. The final product is a low-polluting, biologically stable material that is suitable for landfilling.

The wide range of combinations and sequence of MBT technologies make it a particularly flexible and adaptable process for a variety of wastes and situations.

These techniques also appear to be more affordable, less affected by economies of scale and better perceived by populations than incineration processes, though they can be integrated into thermal treatments.

The main challenge for the process to be efficient and effective is to arrange the sequence of treatments according to the nature of waste being treated.

3.4.1. Stabilisation of residual biowaste prior to landfill

Reducing fermentability requires testing methodology, standards of acceptance and stability measures at landfill sites. Potential parameters could be respirometry[51], potential biogas production, etc.

The European Commission's working document "Biological treatment of biowaste[52]" took account of respirometry in relation to the assessment of the need to pre-treat residual waste before landfilling, and declared that treated residual municipal waste no longer constituted biodegradable waste as described in Article 2 (m) of Directive 1999/31/EC: '*If residual municipal waste undergoes a mechanical/biological treat-*

ment prior to landfilling, the achievement of either a respiration activity after four days (AT4) below 10 mg O2/g dm or a dynamic respiration index below 1,000 mg O2/kg VS/h.

In **Germany**, new legislation banning direct landfilling of MSW took effect from 1 June 2005. The “Ta Si” (Technical Data sheet for the Management of Municipal Solid Waste) requires that the ignition loss of landfilled waste may not exceed 3% by weight – in other words, the regulation limits the organic solids content of waste for landfilling to 3% from 1 June 2005. Technically this limit would only be achievable by means of incineration.

Even though they do not comply with this limit, residues from MBT plants will still be allowed to be landfilled as they are considered to comply with the objectives of the regulations in ensuring the stabilisation of materials to be landfilled regarding their emission of gases and leachate, and their subsidence.

In **Austria**, no material with an organic carbon content of more than 5ppm can be landfilled. However, this ban does not apply to wastes that have been pre-treated via MBT, so long as the maximum calorific value from the combustion of the dry matter does not exceed 6000kJ/kg.

3.4.2. Weight and volume reduction

In reducing the weight of waste to be disposed of, MBT contributes indirectly to the diversion of biodegradable waste from landfill, thereby reducing landfill tax costs.

Volume reduction allows the extension of the lifetime of landfills.

3.4.3. Increase of the calorific value of residual waste before thermal recovery

MBT can be coupled with the thermal recovery of fractions with high calorific value. In addition to the reduction of the biodegradable element, MBT assists indeed in the better separation of the components and to the reduction of the water content. The end-product is then not only more suitable for landfill, but also to the production of the secondary fuel, RDF (refuse-derived fuel).

3.4.4. Production of “grey compost”

Various studies have shown that end-products from MBT have 5 to ten times more heavy metals content compared to compost resulting from source separated biowaste[53] . Therefore, it seems that these treatment methods should remain regulated according to legislation relating to landfilling, and that the application of stabilised biodegradable wastes should be restricted to limited applications (non-agricultural use).

The working document “Biological treatment of biowaste” [54] envisaged the possibility of a limited application (subject to authorisation) of “grey compost” or a “stabilised organic fraction”. These could be used for certain applications that aim to encourage biological activity of surface soils or require a large quantity of materials, for example, the rehabilitation of landfills or mines, decontamination of soils, the construction of noise reduction barriers, and landscaping activities.

Italy also requires that wastes be pre-treated before being landfilled, and has defined two types of stabilisation qualities for organic materials:

- The first can be used as a soil improver in soil decontamination activities requiring authorisation, respecting a maximum load for dry material of 100 tonnes/hectare;
- The second can only be landfilled or used as a landfill cover.

The value limits for the first quality type concerns heavy metals, while the second quality type focuses on the humidity level and respiratory index.

Wetteraukreis district authority (Germany): a future-oriented waste management strategy combining separate collection with the mechanical biological treatment of residual waste

The Wetterau district authority is one of 21 districts of the Land "Hesse", in the north of Frankfurt am Main. Since the beginning of the 1990s, the waste management enterprise of the Wetteraukreis (*Abfallwirtschaftsbetrieb des Wetteraukreises, AWB*) has focused on the combination of different segregated collection systems, combining the composting of the separately collected biowaste fraction, and the mechanical biological treatment (MBT) of residual waste.

Separately collected biowaste

The separate collection of the dry fraction (packaging, glass, paper, etc.) and of small hazardous waste has been successful since its introduction in the early 1990s. Home composting is the top priority in the management of biowastes and is supported by AWB by means of a waste consulting service and the sale of low-priced compost bins.

For those households which cannot compost their own kitchen and garden waste, a door-to-door biowaste collection service has been run since 1995 at a lower charge than for residual waste. 60% of the municipalities of the district have implemented a PAYT ("Pay As You Throw" – polluter pays principle) financing scheme based on the weight collected.

Separately collected biowaste is processed in the District's own composting plant, which has a capacity of 20,000 tonnes/year. After mechanical treatment and extraction of unwanted substances, biowaste is decomposed intensively during seven days in tunnels and is then placed in covered windrows for a two-month secondary composting. Mature compost with different qualities for different uses is sold regionally to private users, and gardening and landscape companies

Residual waste

Due to the increasing waste segregation at source, the residual waste quantities in the Wetterau district have been considerably reduced. Since the construction of a plant only for the use of the Wetterau district would have been financially unviable, a cooperation agreement was created with the neighbouring Vogelsberg district: residual waste collected in Vogelsberg (14,000 tonnes/year) is pre-treated in Wetterau's MBT plant, and the remaining residual waste from Wetterau district is disposed of in the Vogelsberg landfill.

A biomechanical waste treatment plant, capable of treating 45,000 tonnes / year, was built between November 1997 and November 1998 costing €10m. The waste is subjected to several treatment stages:

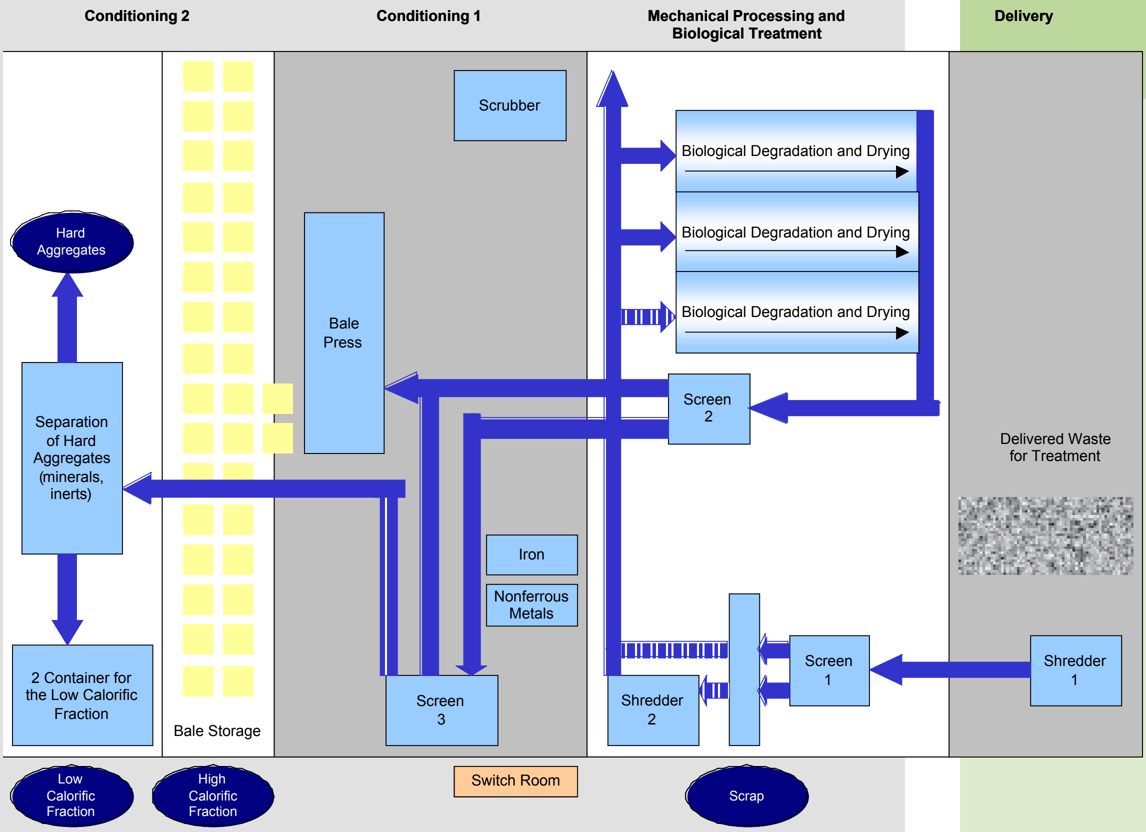
Mechanical processing: waste is sieved (60mm), and iron is magnetically removed.

Biological treatment: waste is biologically degraded and dried for about ten days in three composting tunnels (1,000 m3 each).

Mechanical finishing: the dried material is fed into a second 60mm screen. Material with a diameter of over 60mm is fed to a baler as high calorific fraction. The material with a diameter of less than 60mm has iron and non-ferrous metals separated, and is then fed through a 30mm screen. The material with a diameter of less than 60 and greater than 30mm is also fed to the baler as high calorific fraction. Hard aggregates (minerals, inert materials) are separated from the remaining material (less than 30mm). The latter is loaded into containers and transported to the landfill. The waste air treatment is performed using scrubbers and bio-filters.

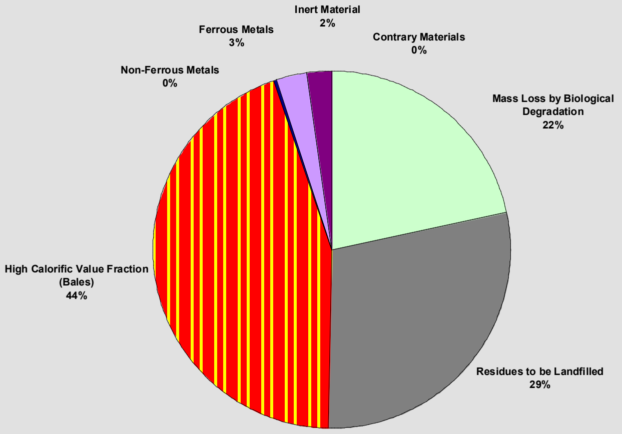
The **high calorific fraction** is sold as refuse-derived fuel, for the production of methanol in the petrochemical industry or in incineration plants with heat extraction. The objectives are to develop other commercial markets and the production of further substitute fuels. **Iron and non-ferrous metals** are sold to the metal-working industry.

Figure 3. Wetteraukreis district authority (Germany): a future-oriented waste management strategy



Separated hard aggregates are used in road construction. Only the **low calorific fraction** is currently disposed of.

Figure 4. Composition of the output material of the MBT plant (2003)



The aim is to extract as many mechanically sortable, recyclable and saleable materials as possible from the low calorific fraction in order to reduce the amount which is disposed of and to comply with the statutory criteria for the landfill of waste.

Outcomes from a 10-year strategy

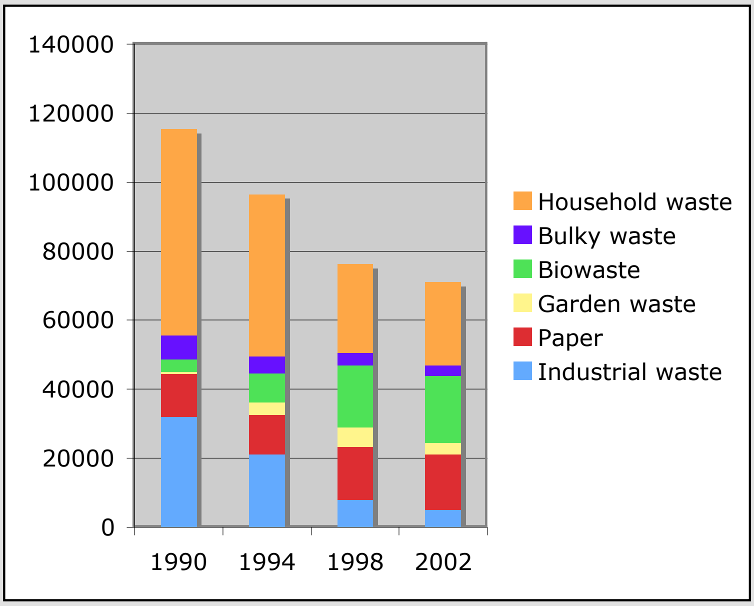
As a result of this policy, the Wetterau district has noticed :

- a drastic reduction in the amount of residual waste produced (residual waste quantities per inhabitant amount to about 100kg – one of the lowest figures for Germany)
- a significant reduction in the waste disposal charges.

Residents have benefited from a reduction in the waste disposal rates of 35 to 40 percent over the last 10 years.

A comparison of the individual waste quantities between 1990 and 2002 also shows the significant shift in the quantity of residual waste to organic waste.

Figure 5. Waste arisings 1990 - 2002 (tonnes)



A look to the future

Diversification of compost types is planned along with increased cooperation agreements with other compost manufacturers (to efficiently develop the production, ensure product quality and markets and distribution of the end-products). As a result of the “Biomass regulation” in Germany, the composting plant will be developed so that large material (branches, roots) can be sorted from the biodegradable waste flow and recycled via the biomass power plants.

AWB has consistently focussed on flexible investment regarding the MBT plant : individual fractions are closely linked to the movements of the recycling markets. The high calorific fraction (18,000 tonnes/year), makes up a considerable percentage of the output. The option is open to process it in the future as an RDF or to use it in combined heat and power units (CHP) plants.

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Further reading:

Centralised sorting of municipal waste (Dewaster installation in Odense, Denmark) – http://www.mst.dk/udgiv/publikationer/2004/87-7614-4/html/sum.htm

Bardos, P; Composting of mechanically segregated fractions of municipal waste – a review, r3 Environmental Technology Ltd, UK 2004 – http://wwwr3environmental.com

Mechanical-Biological Treatment: A guide for decision makers, processes, policies and markets, Juniper Consultancy Service Ltd, 2005

chapter 4

How to go from a waste management to a product manufacturing perspective?

The **range of products** obtainable from the treatment of household biodegradable waste is **relatively wide**:

- compost
- digestates
- soil coverings, such as mulch
- stabilised organic waste (for restricted use or for use as landfill cover)
- without forgetting, biogas...

The 'material' products do not all require the same quality level, and can find uses in **various sectors** such as:

- amateur gardening
- horticulture
- agriculture
- landscape management
- landfill rehabilitation (plant cover)
- ..recognising the last two are not truly 'perennial.

The treatment of household biodegradable waste can generate valuable products such as compost and compost-like products (digestate, mulch, etc.), and biogas.

A waste disposal approach here gives way to a resource recovery approach and to a product perspective. The context becomes commercial: it is about a supply finding a demand, and then securing and expanding it.

Such a perspective anticipates the identification of permanent markets and lucrative outlets for their products as well as to understand customers' needs and requirements in terms of quality (transparency, traceability, etc.), while also supplying security, price, marketing and delivery methods.

4.1. Products from biowaste treatment

4.1.1. Compost and other products

There are various needs and uses for organic matter, and therefore a place for a wide range of products, from the lowest to the highest qualities.

Quality compost can be used either as a soil fertiliser (bringing nitrogen or potassium to the soil), soil conditioner (transferring specific physical properties to the soil), or as a growing media (soil substrate) in :

- agricultural fields
- green areas, forestry
- horticulture (nurseries, greenhouses, etc.)
- for home/ hobby gardening
- etc.

Lower quality composts and stabilised organic substances are preferably used with precaution to improve the quality of other inert materials in old quarries, landfills, green areas along motorways and railways (escarpments, borders, embankments), as well as in public gardens, golf courses, football pitches, etc.

The annual production of compost in **Italy** is estimated to be between 800,000 and 900,000 tonnes / year [55]. Law 748/84 on fertilisers classifies compost as "green composted fertiliser" and "mixed compost fertiliser". Compost obtained from waste separately collected is considered to be a product and can be marketed freely. Compost obtained from waste which is not separated at source is commonly known as stabilised organic fraction (SOF).

4.1.2. Biogas

In addition to the production of a digestate [56], the anaerobic digestion of biodegradable waste generates biogas which may be recovered as heat and/or electricity.

Table 5 : Different types of methane and their energy values [57]		
Waste	**Methane produced (m^3)**	**Equivalent**
1 tonne of biowaste or household residuals	65-75	65-75 L fuel 1-2 Kwh electricity 3-4 Kwh thermal energy
1 tonne of biowaste + green waste + paper/ card	65-75	65-75 L fuel 1-2 Kwh electricity 3-4 Kwh thermal energy
1 tonne of biowaste +green waste	50-60	50-60 L fuel 1-2 Kwh electricity 3-4 Kwh thermal energy
1 tonne of biowaste + paper/card	75-85	75-85 L fuel 2 Kwh electricity 4-5 Kwh thermal energy

4.2. Developing markets for composts

The table below shows that the demand for compost for European soils is well above the potential for production, even if the whole of the population of Europe was served by selective collection systems for biowaste.

Table 6 Percentages of arable land area potentially interested by compost application in EU Countries [58]

Arable land			**Food and green waste compost**	**Arable land needed for compost application**	
Country	Inhabit-ants x 10^6	Total	(ton) f.m d.m.	Total	%
	1995	(ha)	(tonnes) m.s.	(ha)	STA
Austria	81553	12000	3262 1631	163.1	1.36
Austria	8040	1500	321 161	16.1	1.07
Belgium	10131	700	405 203	20.3	2.90
Denmark	5216	2500	208 104	10.3	0.41
Finland	5099	2500	204 102	10.2	0.41
France	58027	18000	2321 1160	116.1	0.65
Germany	81553	12000	3262 1631	163.1	1.36
Greece	10063	3000	402 201	20.1	0.67
Italy	57248	10000	2290 1144	114.5	1.15
Ireland	3577	1000	143 72	7.1	0.71
Luxembourg	407	60	16 8	0.8	1.35
Netherlands	15423	900	616 308	30.8	3.43
Portugal	9912	3000	396 198	19.8	0.66
Spain	39170	16000	1566 783	78.3	0.49
UK	58276	7000	2331 1165	116.5	1.66
Sweden	8816	3000	352 176	17.6	0.58
EU	370958	81200	14833 7416	741.6	0.91

A prior analysisa of markets at the local level is indispensable.

4.2.1. Market shares

Market shares for compost in the European Union are variable but can generally be divided into the following uses:

40 %	Agriculture
30 %	Landscaping
20 %	Hobby gardening
10 %	Other uses

According to various experts:

- agriculture and horticulture should continue to be important outlets for compost, mainly due to the impoverishment of soils in organic matter;
- landscaping has proven to be a good outlet for lower quality compost, but its use is limited ("one-off" applications);
- hobby gardening and the home use of compost should not be neglected as it is a viable outlet which also provides opportunities to make people more aware of the value of biodegradable waste [59].

Costs, benefits and market prospects for the various potential uses of compost should be examined very closely **locally**.

The table below illustrates detailed compost market shares by outlets in a few EU countries.

Table 7 : Market shares of compost sales in EU (Status 1999 to 2001)[60]

<table>
<tr><th>Market share (%)</th><th>AT 2000</th><th>BE (FL) 2000</th><th>D 1999</th><th>DK 2000</th><th>NL 2001</th><th>IT 2001</th><th>LUX 2000</th><th>FR 2000</th></tr>
<tr><td>Landscaping</td><td>30</td><td>26</td><td rowspan="2">25</td><td>13</td><td>10</td><td>15</td><td>28</td><td>19</td></tr>
<tr><td>Landfill + Restoration</td><td>-</td><td>2</td><td>14</td><td>-</td><td></td><td></td><td></td></tr>
<tr><td>Agriculture + Special cultures</td><td>30</td><td rowspan="2">9</td><td>43</td><td>12</td><td>75</td><td>33</td><td>43</td><td>52</td></tr>
<tr><td>Horticulture</td><td>10</td><td>5</td><td>8</td><td>-</td><td></td><td></td><td>5</td></tr>
<tr><td>Earth works</td><td>5</td><td>35</td><td>10</td><td>-</td><td>-</td><td rowspan="2">48</td><td></td><td>15</td></tr>
<tr><td>Privat gardens</td><td>20</td><td>19</td><td>14</td><td>43</td><td>10</td><td>18</td><td></td></tr>
<tr><td>Export</td><td></td><td>5</td><td>-</td><td>-</td><td>5</td><td></td><td></td><td></td></tr>
<tr><td>Miscellaneous</td><td>5</td><td>4</td><td>3</td><td>10</td><td>-</td><td>4</td><td>11</td><td>9</td></tr>
</table>

Many standards levels can guide the transformation of a waste into a marketable product.

4.2.2. Producing quality compost

4.2.2.1. What level of quality assurance?

In order to gain the confidence and trust of final users of end-products, thought needs to be given to the development of product standards. Four different types of standards can be developed:

- at the entrance of the process - for **feedstock**;
- for the composting **process** (trying to ensure the quality control of the composting plant including treatment stages and/or technology used);
- at the end of the process - for the **end-products** (output) by setting limit values for potentially toxic elements and defining agronomic features for compost; and
- for **soil quality.**

Of course, setting rules / standards at any of these stages pre-supposes that their respect is ensured and monitored to the same level.

4.2.3.3.1. Quality standards for compost (input use)

The most common approach regarding input (feedstock) use seems to be a list of materials allowed for composting. This is the case in Germany. However, sometimes such a list of acceptable raw materials can be too rigid, such as when it goes about integrating biodegradable packaging for instance[61] .

Austria, Sweden and the Netherlands have laid down lists of "suitable" materials groups.

In the Flanders Region (Belgium), the primary material type determines the category of final product (see Table 9 below).

Assuring the quality of the incoming material can lead to the creation of a positive list of acceptable materials.

4.2.3.3.2. Process control and standards for operating conditions

Statutory process control in most countries is limited to hygiene and sanitisation aspects. The objective is to ensure that the treatment process leads to a product which:

- *is hygienically safe;*
- *contains no pathogenic bacteria (such as salmonella);and*
- *and in which weeds and plant seeds have been minimised[62] .*

Such processes most often define conditions for odours and temperature–time (requiring that the compost is raised to a minimum temperature for a minimum period of time).

QUALORG Eight local authorities (F) and the Department of Boblingen (D) create a quality approach to ensure a permanent market for biodegradable waste recovery

Between 1998 and 2002, ADEME (the French Agency for the Environment and Management of Energy) undertook a European Union LIFE project called Qualorg (European Programme for the quality recovery of organic waste). The project was delivered by the close collaboration of 9 local authorities (8 in France and 1 in Germany) that were organising or implementing a selective collection system of biowaste for composting.

The QUALORG project aimed to define:

1. a methodology for the implementation of a quality assurance system for the selective collection and composting of biowastes. The quality assurance aimed to address the users of the collection system and the users of the composts produced.
2. technical and economic indicators assessing the performance of the systems for the collection of the materials and the outlets for the composts.

To achieve these aims, QUALORG looked to the ISO9000 series of quality management and adopted the action plan process of "Planning – Implementation – Evaluation – Improvement".

Organisational and operational elements were managed through 6 themes:

- an engagement approach – the role of elected officials was identified as a fundamental element and as a guage of success;
- good management of the collection system – this helped to ensure the quality assurance of the end-product while addressing the concerns of the users;
- good management of compost production – this ranged from the control of incoming materials (feedstock), the monitoring of hygiene, and the stocking of compost in a way that guaranteed its stability;
- quality and distribution of the compost – this required the production

Assuring the quality according to treatment procedure, means assuring that the compost produced is hygienic in terms of the production process (monitoring of temperature), or that the odours and different emissions have been managed according to good practice, or even that its integrated traceability 'waste-products-resources' is guaranteed.

The quality of an end-product is measured by various parameters such as level of physical impurities (plastic, glass, stones, etc.), heavy metals levels, the concentration of organic pollutants, the presence of pathogenic agents, weeds, stability, phyto-toxicity, etc.

of a product that met current standards, and to agree with clients about specifications;
- external consultation and communication – involving all the relevant groups, including service providers, compost users, farmers' associations, consumer associations, and the residents-sorters (the first link in the quality chain);
- staff training and internal communication.

This project showed that an approach could be developed and adopted if authorities wished to implement and improve a selective collection system and the composting of biodegradable household waste.

QUALORG ended in 2002 and ADEME wishes to promote to other authorities the approach developed through the project. It now intends to create a QUALORG quality frame of references for collection and production chains for organic improvers from biodegradable household and similar waste. ADEME is currently working with a certifying organisation to draft, disseminate and communicate this quality frame of references.

A set of documents have been developed by ADEME which can be found at http://ademe.fr/htdocs/Frame_publications.htm. Click on the QUALORG directory.

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4.2.3.3.3. Quality definitions of end-products

Types of requirements

Common basic requirements for standards regarding the quality of end-products generally address :

- **heavy metals:** (see the Table below for heavy metals limits for compost standards in various countries). Tolerance thresholds or deviation limits have been developed (for example, in Germany and the Netherlands), which help to ensure a level of security and stability in compost production.
- **organic pollutants**: these are generally present in very low levels in source-separated materials. In the case of organic farming, the question of possible contamination with genetically modified organisms has become an important point.
- **presence of pathogens, impurities and weeds**: almost all countries with existing standards have developed assessment criteria to measure the content of pathogens, and the presence of impurities and weeds

Table 8: Heavy metals limits set by different European compost standards (mg/kg of dry material, unless otherwise indicated) [63]										
Country	**Regulation**	**Cd**	**Crtot**	**CrVI**	**Cu**	**Hg**	**Ni**	**Pb**	**Zn**	**As**
EC	Draft W.D. Biological Treatment of Biowaste (class 1)	0.7	100		100	0.5	50	100	200	
	Draft W.D. Biological Treatment of Biowaste (class 2)	1.5	150		150	1	75	150	400	
Ecolabel EC	2001/688/ EC	1	100		100	1	50	100	300	10
EC/'eco-agric'	2092/91 CE- 1488/98 E	0.7	70	0	70	0.4	25	45	200	
Germany	Quality assurance RAL GZ – compost /digestion	1.5	100	–	100	1	50	150	400	–
	Bio waste ordinance (II)o	1	70	–	70	0.7	35	100	300	–
	Bio waste ordinance (II)o	1.5	100	–	100	1	50	150	400	–
Austria	Compost Ordinance: Quality Class A+ (organic farming)	0.7	70	–	70	0.4	25	45	200	–
	Compost Ordinance: Quality Class A (agric.; hobby gardening)	1	70	–	150	0.7	60	120	500	–
	Compost Ordinance: Quality Class B (land-scaping; reclaim.) limit value	3	250	–	500	3	100	200	1800	–
	Compost Ordinance: Quality Class B (land-scaping; reclaim.) guide value (if exceeded to be marked within labelling)	–	–	–	400	–	–	–	1200	–
Belgium	Ministry of Agriculture	1.5	70	–	90	1	20	120	300	–
Denmark	Compost after 01 06 2000	0.4	–	–	1000	0.8	30	120/60 priv. gardens	4000	25
Spain	Decr.1310/1990 pH>7 (sewage sludge in agriculture)	40	1500	–	1750	25	400	1200	4000	–
Spain	Decr.1310/1990 pH<7 (sewage sludge in agriculture)	20	1000	–	1000	16	300	750	2500	–
Spain	Order 28/V/1998 on fertiliser B.O.E.n'm.131.2 June 1998	10	400	–	450	7	120	300	1100	–
Spanish draft on composting	Classe AA	2	250	–	300	2	100	150	400	–
	Classe A (Stablised Biowaste)	5	400	–	450	5	120	300	1100	–
Catalunya draft on composting	Classe A	2	100	0	100	1	60	150	400	–
	Classe B (Stablised Biowaste)	3	250	0	500	3	100	300	1000	–
Finland	Fertilised growing media	3	–	–	600	2	100	150	1500	50
France	NF Compost Urbain	3				8	200	800		
Greece	Specifications framework and general pro-grammes for solid waste management	10	510	10	500	5	200	500	2000	15
Ireland	Limits in recent licences	10	510	10	500	5	200	500	2000	15
Italiy	Limit values for solid organic fraction	10	500	10	600	10	200	500	2500	10
	Green (ACV) and MIXED [64] (ACM) Com-posted Amendment	1.5	–	0.5	150	1.5	50	140	500	
Luxembourg	Licensing for plants	1.5	100	–	100	1	50	150	400	–
Netherlands	Compost	1.5	100	–	100	1	50	150	400	–
	Compost (very clean)	1.5	100	–	100	1	50	150	400	–
Portugal	Decree on sludge (limit values utilised also for MSW)	20	1000		1000	16	300	750	2500	–
Sweden	Guideline values of QAS	1	100	–	100	1	50	100	300	
UK	UKROFS 'Composted household waste'	0.7	70	0	70	0.4	25	45	200	_
	Composting Association Quality Label	0.7	70	0	70	0.4	25	45	200	_

The Animal By-Products Regulation [65] (ABPR) will have a direct impact on composting and AD plants in relation to catering wastes.

The principal concerns for animal by-products relate to the higher risk of spreading disease through the spreading of products onto soil. The European regulation authorises the composting and anaerobic digestion of kitchen waste and other categories of waste with lower risk levels (such as butchery of healthy animals), and establishes basic regulations for pasteurisation/hygienisation for these installations[66] .

Moreover, following the principle according to which the use of meat and bone meal are prohibited as animal feed, Article 22(1)(c) of the ABPR prohibits the application to pastureland of organic fertilisers and soil improvers, other than manure.

An exception is made for the use of composts or digestate stemming from "Category 3" material (low-level risk products such as kitchen waste) so long as a waiting period of three weeks between spreading and grazing is observed.

London Borough of Lambeth (UK) : Termination of a successful "total recycling trial" due to lack of processing facilities compliant with the ABPR

In 2003 the Recycle Western Riverside Campaign (RWR) and London Remade worked with the inner London Borough of Lambeth, to part-fund and implement a 'total recycling' trial, involving the separate collection of dry recyclables alongside collection of mixed organic kitchen and garden waste.

The total recycling collection scheme proved extremely effective in diverting material for processing, as diversion increased from 19% to an average of 46% following the introduction of the trial. 13% of this increase was achieved through collection of organic material.

	Pre-trial				Average during trial			
Measure	**Refuse**	**Dry recyclables**	**Organics**	**Total diversion**	**Refuse**	**Dry recyclables**	**Organics**	**Total diversion**
kg/hh/yr	672	156	0	156	458	286	116	402
Percentage	81	19	0	19	53	33	13	46

Although the decision was taken to end collection of the organic element of the waste (collections of dry recyclable materials continued as the scheme had been introduced Borough-wide), the main reason was the lack of local processing facilities that were compliant with the UK Animal Bi-Products Regulations (ABPR).

In England, ABPR do not allow use of composted kitchen organic material on land unless it has been processed by a site certified as ABPR compliant by the State Veterinary Service (SVS). For a site to be certified by the SVS it must meet a set of stringent requirements and show that it is able to consistently meet these requirements over a period of time.

This means certification of sites can be a lengthy process. Until a site is fully certified, no composted material can be used on land, it must be landfilled or used as landfill cover.

Neither of these options allows authorities to count the material processed towards their statutory recycling and composting targets or targets set under the Landfill Allowance Trading Scheme (see 8.2.2.1.).

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- **physical impurities**
- **product stability** (refers to its biological decomposition)
- **product maturity** (addresses its ability to support plant growth)
- **phytotoxicity** (refers to the potential for detrimental effects of compost on plant growth)
- **additional end-user specifications** (which are not mandatory for the granting of the label or of the certificate) which may consist of: organic matter, stability, nutrients, conductivity, moisture content, porosity, plant compatibility, degree of decomposition (Rottegrad), salt and water content, etc.

The properties of the end-product often lead to the creation of « classifications » of compost quality (as in Austria, Germany, the Netherlands, etc.)

Recommendations on the use of products provide a good complement to these specifications.

Germany, Austria and the Flanders Region in Belgium define already further standards for **specialist products**, as certain users have specific requirements (e.g. organic farmers) which can lead to the exclusion of certain categories of materials.

In any case, limit values should at least assist in the clear definition of when compost becomes a product; and should lead to as simple a classification as possible.

Table 9: Classes of compost defined by some European countries[67]

	Number of classes		Description
Austria	3	Direct quality classes based on heavy metals limits	• Class A+ (top quality, suitable for organic farming) • Class A (high quality suitable for agricultural uses) • Class B (minimum quality for non-agricultural uses)
Flanders	3 (VLACO)	Quality classes based on raw materials	• Biocompost (from source-separated biowaste) • Humotex (from aerobically composted digestion residuals) • Green waste (compost from source-segregated
Germany	2	Quality based on the properties or the ranges of use	These 2 classes are defined regarding their heavy metals content
Netherlands	2	Direct quality classes based on heavy metals limits	Good compost and very good compost are distinguishable following their heavy metals limit values

4.2.2.1.4. Monitoring of soil quality

<u>Restrictions on spreading of composting on soil and the monitoring of the soil</u> also has a role in considering 'quality'.

Regulation of potentially harmful aspects of compost production and use often ends with standards on the environmental / health aspects of the application of compost to land.

Loading limits (and spreading programmes) are an element of a preventive approach. They consider the concentrations of heavy metals as well as the nutrient content.

These standards can potentially hinder the development of markets for compost products, but they function of course in the scope of wider contexts. They can be considered as successful as far as they allow the sale of as many products as are produced and needed, while protecting the environment and satisfying end-users.

4.2.2.2. Is selective collection necessary?

Biowaste treatment technologies and sorting techniques have been evolving over time. Some voices claim today that selective collection is no longer necessary to transform household biowaste into quality products.

It is beyond the scope of this report to provide an absolute answer to this question. Local factors such as the legal framework, existing infrastructure, waste disposal costs, environmental objectives and political will, as well as local markets for recovered material, are determining factors in deciding on a waste treatment option.

What remains crucial is that sustainable outlets have to be found for the materials recovered from the composting process. With that view, ensuring end-users' confidence is essential. Even if local markets appear to be able to absorb the biowaste product produced, selling compost demands that the product have consistent quality and that it meets users' needs.

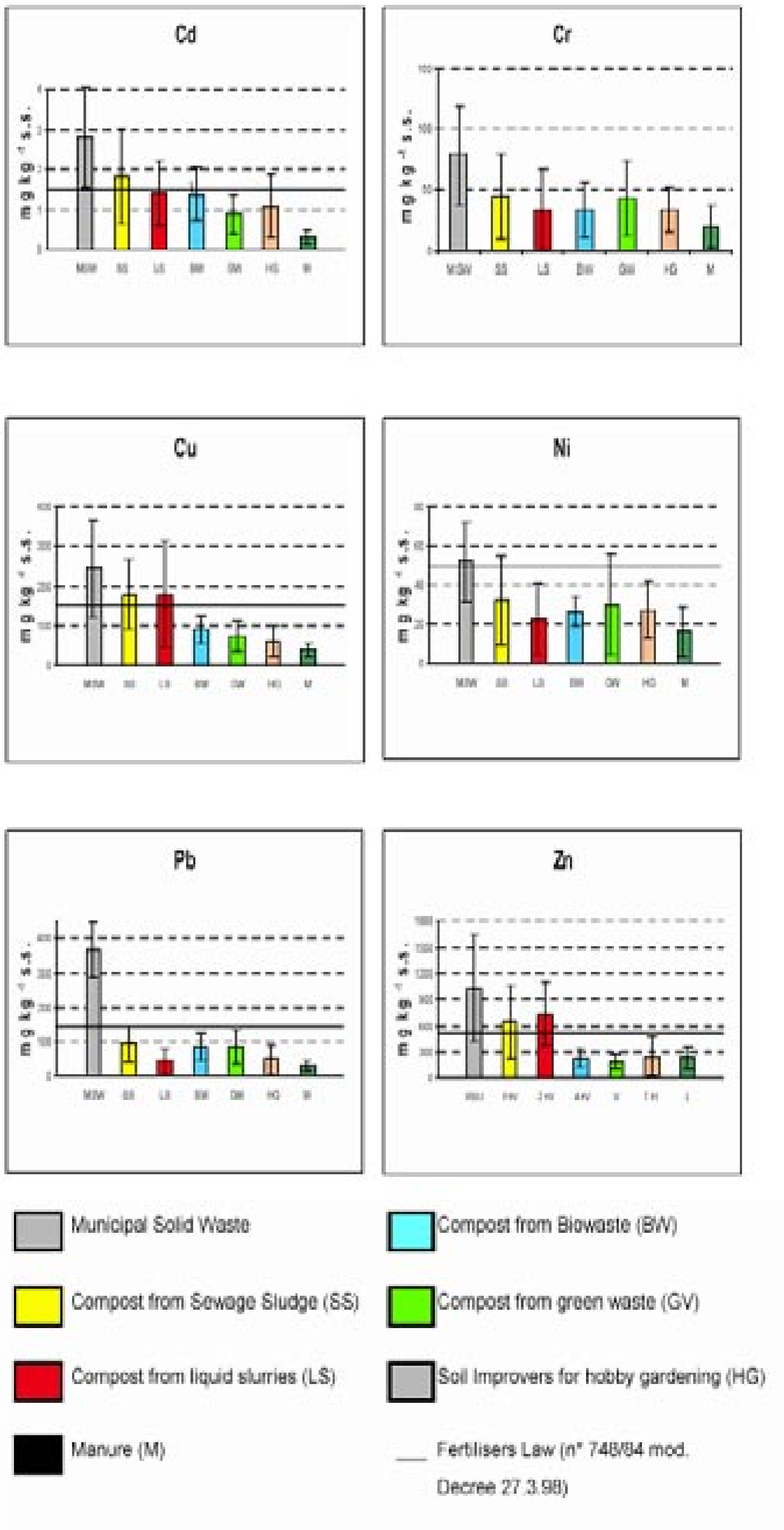
The figures below present a range of concentrations of heavy metals in soil improvers from different feedstocks, according to the Italian Fertiliser Law limit values.

Obvious variations for different types of feedstock show that it is possible when comparing samples to find cases where compost from mixed waste complies with quality standards for compost in Italy. Some samples even show the same quality as compost from selectively collected biodegradable waste.

However, there are obviously wide variations of quality between samples within one category, and if we consider tendencies related to frequent analysis of a wide range of samples :

- compost from sewage sludge is more contaminated than source-separated biowaste and green waste composts;
- composts from mixed municipal solid waste are more contaminated than sludge composts;
- compost from source-separated materials performs well in comparison with other soil improvers and growing media.

Figure 6 : Heavy metals in soil improvers from different feedstocks, (Centemero, 2000)



Ensuring outlets for end-products depends on the confidence of users and the competitiveness of the products. These assume that the products offer a **guarantee of quality and safety.**

If it is possible to produce a substrate qualifiable as ‘compost’ from mixed waste, the trends from the analysis of a large number of samples show that this ‘compost’ generally has high levels of contamination, particularly of heavy metals.

Figure 7 : Lead concentrations in “Urban Compost A” (from selectively collected biowaste) and “Urban Compost B” (from mixed MSW), compared to limit values of the Walloon Region (IDELUX, B, 2004)

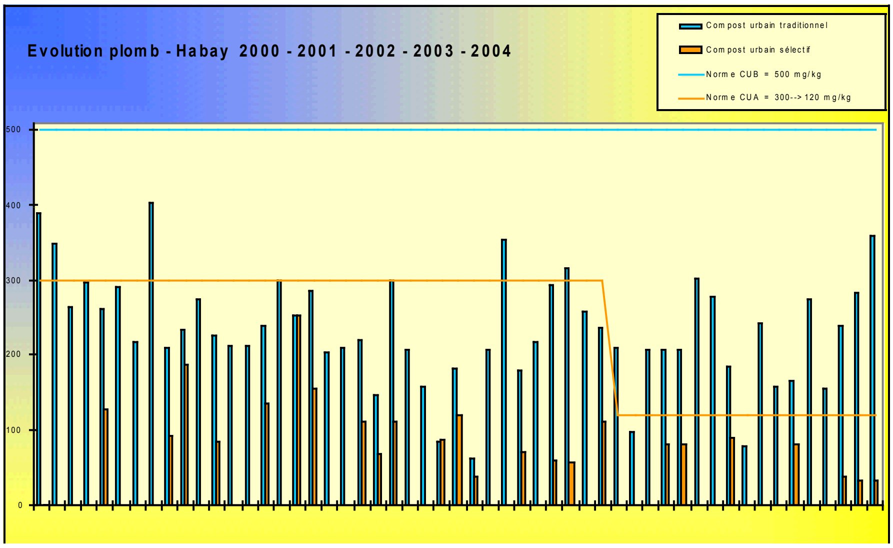
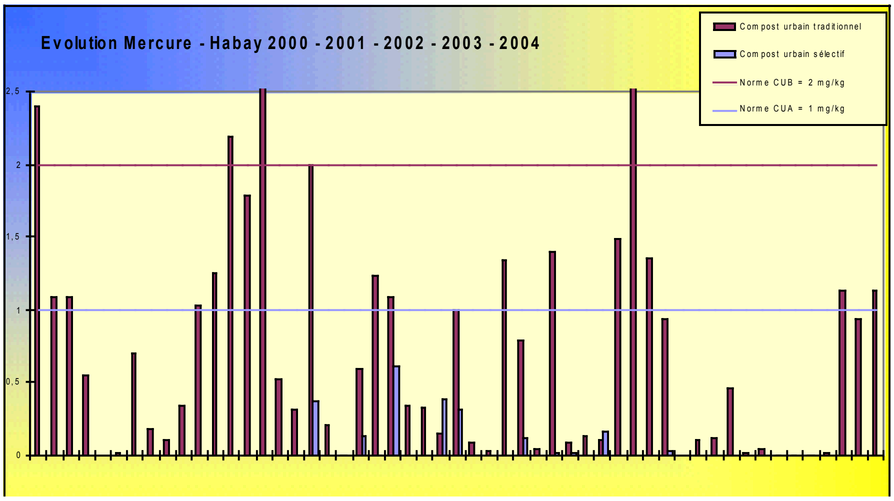


Figure 8 Mercury concentrations in “Urban Compost A” (from selectively collected biowaste) and “Urban Compost B” (from mixed MSW), compared to limit values of the Walloon Region (IDELUX, B, 2004)



The two analyses above, undertaken by a sub-regional waste authority, IDELUX, in Belgium, show specific heavy metals limits found in two different types of compost. ‘Urban Compost A’ is made from selectively collected household biowaste, and ‘Urban Compost B’ is made from mixed municipal waste.

These analyses show that, although compost from mixed municipal waste collection systems, can respect heavy metals limits, statistically they exceed these limits more often than compost from selectively collected materials. Beyond “quality” in its strictest sense, selective collections of biowastes appear to more consistently ensure such a quality product, over time – something that is crucial for the trust of users.

The production of **high quality products** seems also to present the best guarantee in use, the greatest variety of applications for the product, and the best potential for sale of the product, while allowing users to consider using the compost with no restraints beyond the usual agricultural good practices.

Lower-quality products also have outlets, particularly in soil rehabilitation and landscaping, or on specific agricultural land. However, as vineyards and olive groves do not have the same requirements as nurseries with young plants, the on-going use of the product needs to be carefully considered according to its long-term effects. It appears that composts made from mixed municipal waste should be restricted to limited applications.

4.2.2.3. Guaranteeing quality of the waste-product cycle

There are a variety of statutory and voluntary instruments which can promote both compost production and its positive perception by the public.

4.2.2.3.1. Quality assurance systems (QAS)

Around 550 large composting and AD plants in Europe are controlled by Quality Assurance Systems (QAS). These plants, for the most part located in Austria, Belgium, Germany, Luxembourg, the Netherlands, and Sweden, treat around 70% of the source-separated organic waste in Europe. In these countries, compost products are used in large volumes for a variety of applications[68], and materials derived from mixed MSW and those with high levels of contamination, are placed outside the definition of compost products.

QASs can be seen as closing the organic loop since they link compost production to markets for their use, and their existence will influence all the stages of the treatment of organic residues (separate collection, plant engineering, compost production, development of compost products achieving specific standards and tailored for different application ranges, information regarding the development of policies and regulation, etc.). QASs also contribute to ensuring that end-users receive information regarding compost quality; composition data; nutrient availability; the nitrogen, phosphorus, and potassium content of compost; and recommendations for use[69].

Users of compost also benefit from a standardised quality product that is verified by independent organisations[70]. Therefore, QASs make a positive contribution to the image of the product and is a powerful basis for marketing.

In general, quality assurance standards will link the existing legal standards to:

- **official standardisation organisations** that are well-known (e.g. RAL in Germany, KIWA in the Netherlands, ÖNORMs in Austria)
- **official quality management procedures** (e.g. ISO 9000 in Sweden and QUALORG in France)
- **eco-labels** (e.g. VLACO in the Flanders Region in Belgium)

Even though they share common principles, the different European quality assurance systems also have their own individual characteristics.

In **Germany**, the BGK (Bundesgemeinschaft für Kompost) puts more emphasis on the quality of the end-product than on the process involved, with the exceptions that :

- the raw material types need to be declared;
- the hygienic effectiveness of the decomposition process must be assured.

In **Austria**, the KGVÖ / BKAL is very similar to the German QAS, but the manager of a plant has to go through a specific training programme, and a diary has to be kept with details concerning the plant operation.

In **Italy**, based on a voluntary agreement between specific installations and the Italian Composting Association (CIC), the system mainly focuses on the end-product. It includes:

- a requirement to detail the raw material types that have been composted
- a monthly sampling of compost produced, organised by the CIC and performed by professional labs authorised and contracted by CIC, to assess the effectiveness of the decomposition process and hygienisation.

Do you always need to make selective collection of biodegradable waste the second level in a hierarchy of biodegradable household waste ? Not necessarily, but you need to be realistic about outlets.

Voluntary **Quality Assurance Systems (QAS)** developed in many European countries positively influence the whole of the 'waste-products-resources' cycle: in effect, they make the link between the management of waste, and the production of composts, their commercialisation, and they offer an excellent basis for marketing.

In the **Netherlands**, the KIWA monitors the end-product by self-monitoring (internal production control) undertaken by the installation itself. In **Sweden**, production control is undertaken by the certification organisation.

In **Belgium**, VLACO vzw has developed a highly-integrated quality management system. It not only promotes source separation and home composting, but also manages the QAS system for the composting plants, provides advice on compost application and is responsible for compost marketing. Therefore, all the elements of the organics loop are managed by one organisation.

Flanders Region (B) : Total Quality Control System for compost

VLACO vzw was established as a co-operation between OVAM (the Flemish Agency for Waste Management), the association of municipalities for waste management, private compost producers and some cities. VLACO vzw represents the composting sector in Flanders, with around 50 members and about 30 compost producers.

Quality assurance and research reinforce an effective marketing strategy.

VLACO vzw has implemented a Total Quality Control System for compost. Based on the quality system ISO 9000, standards have been developed with specific requirements for the production of compost. The input (biowaste or green waste), the process and the output are monitored and analysed. VLACO vzw organises regular plant visits to monitor input materials, process conditions and product quality[71]. The quality assurance system is integrated into Flemish legislation, through a control mark for compost or digestate from biowaste.

The Table below illustrates current quality standards for compost in Flanders. Standards for digestate are under development.

Table 10: Compost standards in Belgium

	Compost	Units
GENERAL		
Sieving at 40 mm	>99	%
Dry matter	>50	% by weight
Organic matter	>16	% by weight
pH (water)	6,5-9,5	-
NO3-N/NH4-N[1,2]	>1	-
HEAVY METALS		
Cd	<1,5	mg/kg DW
Cr	<70	mg/kg DW
Cu	<90	mg/kg DW
Hg	<1	mg/kg DW
Pb	<120	mg/kg DW
Ni	<20	mg/kg DW
Zn	<300	mg/kg DW
IMPURITIES, WEED SEEDS, CRESS TEST		
Impurities >2mm	<0,5	% by weight
Stones >5mm	<2	% by weight
Weed seeds	0	#/l
Cress test[1,2]	<10 %	%
SELF-HEATING TEST		
Temperature[2]	< 40	°C

(1) Only for green waste compost

(2) For green waste compost: compliance with two out of these three standards is considered acceptable

VLACO vzw **research** programme investigates how and under which conditions different types of compost can be used for various applications, with a focus on long-term effects.

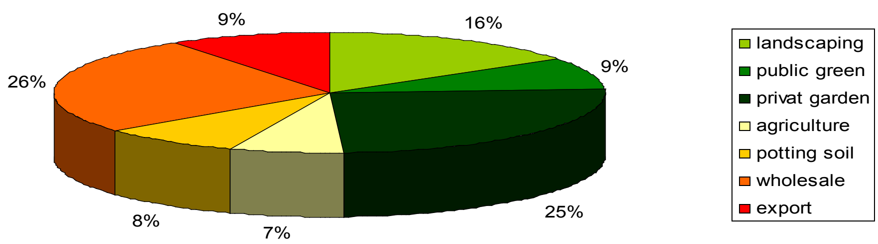
It is pointless to have selective collection and composting if the end-product is not used efficiently. The **marketing** activities of VLACO vzw are therefore considered of major relevance. Much emphasis is put on the specific characteristics of compost which is not a chemical fertiliser, nor a potting soil, and on the possible use and application conditions for the different compost types.

Table 11 shows the number of plants and the annual tonnages of compost produced in the Region. Figure 6 illustrates the market shares for the compost.

Table 11: Different compost types in the Flanders Region (Belgium)

	Green waste compost	Biowaste compost	Industrial biowaste compost	Digestate
Number of plants	22	9	1	In development
Annual production of compost (tonnes)	227 000	136 000	9 500	In development
Market	Landscaping, potting soil, agriculture	Landscaping, agriculture	Landscaping, agriculture	Agriculture

Figure 9 : Market shares for VLACO vzw - compost



Since December 1998, VLACO vzw also has responsibility for **waste prevention and home composting**. These activities have been fully integrated within the structure and work programme, and include the training of "compost teachers", as well as the provision of technical and administrative support.

For more information about composting and digestion in Flanders : www.vlaco.be E-mail : info@vlaco.be Tel : +32 15 451 370.

4.2.2.3.2. Legal framework

Quality Assurance Systems usually depend upon the legal framework that exists in a given country.

The existing legal frameworks often are a result of 'preventive' requirements (regarding hygiene, harmful substances, impurities, etc.) and generally cover the "waste aspects of compost", establishing either:

- a basic set of requirements, e.g. a list of heavy metals limits for compost (as in The Netherlands and the Flanders Region in Belgium); or
- an extensive framework covering some or all of the stages of the whole biological waste management cycle: waste collection, treatment, analysis, monitoring, end-products and application requirements (such as in Austria and Germany where detailed requirements for the marketing of compost are also included). For instance, in Germany, municipalities can regulate what should be collected in the bio-bin.

In Flanders, it is the type of primary material that determines the category of end-product.

The national legal frameworks for the management of biodegradable waste can consist of:

- 'waste' regulations requiring, for example, selective collection of the organic fraction,
- 'product' regulations of varying ambitions that aim to protect soils and crops (heavy metals concentrations, pathogenic agents, etc.),
- And at times regulations on water and soils.

These regulations can be completed by others, for example relating to water and soil.

In Europe, current compost standards are mostly based on the:

- heavy metals content
- type of raw material (decisive in Austria, Belgium, Denmark, Germany, Italy, Spain and Sweden)
- degree of maturity (definition classes in Australia, Germany, Luxembourg and Spain)
- acceptable applications established for instance in Austria & Germany.

Further reading:

Comparison of Compost Standards Within the EU, North America and Australasia (main report and nation specific supplements), D. Hogg and al., WRAP, June 2002, www.wrap.org.uk
Compost of Mechanically segregated fraction of municipal solid waste – A review, P. Bardos, r3 Environmental Technology Limited, 2004.
Centralised Sorting of Municipal Solid Waste (DEWASTER), Ewoc A/S – Danish EPA, Odense, August 2004.
Heavy metals and organic compounds from waste used as organic fertilisers, ENV. A.2./2002/0024, Amlinger and al., Commission européenne, July 2004.

IDELUX (Belgium): Compost quality assurance from biodegradable waste in an association of municipalities in the Walloon Region

IDELUX is a sub-regional integrated household waste management authority, serving 44 local authorities in the Luxembourg Province of Belgium and 11 neighbouring authorities in the Province of Liège in South East Belgium. The area is mostly rural, attracts many tourists, and is sparsely populated (with a total of 316,000 residents, living in a density of fewer than 50 people/km^2).

IDELUX has created a selective collection system based on the ‘bring’ concept. The residents are served by 52 civic amenity sites, 1,337 glass bring banks, 1,140 packaging sorting sites in schools, 2 sorting centres for the civic amenity site waste and inert industrial waste, and 2 sorting/composting sites for household waste.

Biodegradable wastes make up one of 20 types of wastes collected by IDELUX, each of which have their specific systems for their management.

Door-to-door selective collection for organic materials was experimented with from 1996 to 2001, through many pilot projects in different authority areas and after some adaptations the results were found to be very encouraging. By the beginning of 2005, door-to-door collection was provided to all the residents in the region, using:

- electronically-chipped duo-bin (one compartment for the residual fraction, the other for the organic fraction) – the more popular system being used
- by specific bags for residual and organic wastes.

These two systems do not require the organisation of a supplementary collection.

It is worth noting that:

- The selective collection of organic wastes has boosted levels of collection of other materials, such as packaging and hazardous waste. The quantities collected have respectively increased to 42kgs per person per year (including 31 kgs glass), and to 2kgs per person per year.
- The composts produced from the organic wastes collected selectively contain very low levels (at times non-existent) of heavy metals.

The composting process

The two composting centres use the windrow system with regular turning. Kitchen waste is composted in a covered hall, and green waste is shredded and composted in the open air. Each windrow has a unique monitoring file which follows it (including information on the date of the creation of the windrow, temperature, and dates of turning). Once the compost is mature, each 1,000-tonne batch of compost is analysed, and as for the windrows, each batch has a unique monitoring file attached to it.

Sampling and analysis

The compost produced needs to meet certain quality agronomic standards and heavy metals concentrations limits.

		Frequency : monthly - lots: MAX. 1000 Tonnes			
		Compost from selectively collected household waste		Green waste compost	
Parameters	Units	Federal Agency for Food Chain Safety	Walloon Government Certificate	Federal Agency for Food Chain Safety	Walloon Government Certificate
Cd	mg/kg D.M.	1.5	1.5	1.5	1.5
Cr	mg/kg D.M.	70	100	70	100
Cu	mg/kg D.M.	150	100	90	100
Hg	mg/kg D.M.	1	1	1	1
Ni	mg/kg D.M.	20	50	20	50
Pb	mg/kg D.M.	300	120	120	120
Zc	mg/kg D.M.	600	400	300	400
Co	mg/kg D.M.		40		40
As	mg/kg D.M.		20		20

An internal laboratory undertakes phyto-toxicity and maturity (Rottegrad) tests at different stages of the compost's development. Additionally, each batch has 3 samples taken of it. One sample is sent for analysis to an authorised laboratory, the second is sent to the Regional Environmental Police, and the third is kept by the producer. The average cost per analysis is €1,500 per batch of compost (1,000 t).

If a batch is found to be compliant, IDELUX markets it in collaboration with an independent private company. If the batch is not compliant (which is the case for less than 10% of the compost produced), it is used for landfill cover. A non-compliant batch is never mixed with a compliant batch.

The different types of compost are treated separately from start to finish, including marketing. They are sold for agriculture, horticulture, to parks and gardening companies as well as to private users. For this last group, 40-litre bags of Green Waste Compost are sold at civic amenity sites.

IDELUX covers almost all the **commercialisation costs** for the compost (in the Walloon Region and in France). Although the operation is not completely self-financing through compost sales, all the compost is sold. In 2004, around 20,660 tonnes of organic material was produced and sold, resulting in income of €154,800.

Traceability of the products

IDELUX ensures the full traceability of its compost to the level of the operational process. The independent private company it works with in marketing activities assures traceability of the spreading of compost on agricultural land and in allotments. The soils or the spread compost are analysed prior to their spreading on land.

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Further reading :

Hogg, D., and others, Comparison of Compost standards within the EU, North America and Australasia, WRAP, June 2002 (main report and supplements)

Amlinger, Fl., Pollak, M., & Favoino, E., Heavy metals and organic compounds from wastes used as organic fertilisers, Study for the European Commission, ENV. A.2./ETU/200/024, July 2004
http://europa.eu.int/comm/environment/waste/compost/

Guidelines for the specification of composted green materials used as a growing medium component, WRAP, UK, June 2004

chapter 5

What are the collection options?

The levels of development of national biodegradable waste management strategies in Europe are varied. It is obvious that, for the majority of local authorities who are already meeting the objectives of Directive 1999/31/EC, these are separately collecting their biodegradable waste.

5.1. Biodegradable waste management in Europe : state of the art

The Landfill Directive (1999/31/EC) seeks to harmonise Member States' performance in diversion of biodegradable waste from landfill and requires that they produce national strategies on recycling, composting, biogas production or materials/ energy recovery' [72]. The strategies that have been produced vary greatly.

In general, local authorities which landfill less than 20% of their municipal biodegradable wastes, separately collect more than 40%[73] . In Austria and Germany, over 75% of biodegradable municipal waste is collected separately and composted; in some countries like Greece, Ireland and the UK rates are less than 10%.

Table 12 : State of the art source separation (and composting) of biowaste in Europe [74]

Country	Biowaste policy stage
Austria, Belgium (Flanders), Germany [75], Switzerland, Luxembourg, Italy [76], Spain (Catalonia), Sweden, the Netherlands	Countrywide implemented policy. Recovery of 80% of separately collected organic waste, mostly by composting. Austria, Germany and the Netherlands now achieve or surpass a specific compost capacity of 100 kg/ inhabitant / year.
Denmark, United Kingdom, Norway, Belgium (Wallonia)	Parts of the political, quality and organisational framework for separate collection and composting.
France, Finland	Strategies developed at the starting point.
Spain, Greece, Ireland, Portugal	Local strategies mainly consisting of composting mixed urban wastes with no efforts to compost separated organic waste.
Slovakia[77]	01/01/2006 : green waste has to be source separated 01/01/2010 : source separation for 5 items, including kitchen waste

5.2. Choosing selective household biowaste collection

One of the most crucial questions for local authorities whether or not to introduce a selective collection system.

Many local authorities see as problematic the setting up of an (additional) source separation system for biowaste. This is for several reasons:

- The difficulty in motivating citizens to correctly separate one or more types of organic materials in addition to other recyclables;
- insufficient space for sorting waste and storing bins inside but also outside dwellings in urban areas;
- accessibility problems regarding collection in inner cities;
- fear of increasing costs (logistic, human and material) and questions regarding the financing of collections;
- uncertainty over the expected quantities that will be collected, the quality of waste, and the frequency of collections;
- questions regarding the integration of the commercial sector (hotels, restaurants, canteens, etc.).

Those questions are not specific to biowaste. They apply as well to other materials such as dry recyclables, brown goods and packaging. The fundamental question is how a separate collection for biowaste can be optimised and integrated adequately within the collections of other waste streams.

Selective collection programmes undoubtedly require extra efforts and/or investments from citizens and local authorities. They can, however, be compensated by advantages and savings at later stages, as increased costs for collection and educational activities may be off-set later on by reduced capital and labour costs at the processing facility. Selective collection also contributes to the production of a consistently higher-quality compost which is the determining factor when the objective of the scheme is to produce a marketable product.

Source-Separated collection of biowaste	Mixed waste collection
Advantages	**Advantages**
• Fewer risks of materials' contamination. This can result in a higher-quality compost. • Less money and time spent on handling and separating materials at the composting facility • Provides an educational benefit to residents and can encourage waste reduction. • Can improve the performances of other selective collection.	• No additional equipment. • No additional labour needed for collection.
Disadvantages	**Disadvantages**
• Requires the proper participation of the citizens. • May require additional equipment (purchase of new collection equipment and/or containers). • May require more labour for collection.	• Processing costs will include those relating to mechanical sorting. • Higher potential for contamination which can result in a lower-quality compost and difficulties in finding outlets. • May require more frequent product sampling and analysis.

Of course, the potential for recovery of biowastes also depends on various local factors, including:

- local geographical and physical parameters (population density, type of housing, climate, etc.)
- existing legal framework;
- existing collection, processing and disposal infrastructure;
- waste disposal costs;
- markets for the quality of compost produced and for other recyclables;
- etc.

The choice of collection method will depend not only on the type of waste streams to be collected, but also on the downstream treatment options.

Dutch local authorities separately collect vegetable, fruit and garden waste for 10 years

The separate collection of vegetable, fruit and garden (VFG) waste is compulsory in Dutch local authorities since 1997[78] . Today, it is obvious to all the residents, but in 2004, when the national waste management plan was reviewed, this legal status was questioned. At the request of the Secretary of State for the Environment, the Afval Overleg Orgaan [79] undertook a study [80] on the issue, examining the advantages and inconveniences of separate collection of biodegradable wastes according to economic, environmental and citizens' perceptions aspects.
The main observations of the study are:

- **collection and treatment scenarios**. In the short-term, the scenarios that are the most reliable and easily available on a large scale are: 'selective collection and composting', 'selective collection and AD', and 'mixed collection with incineration'. However, some experts are of the opinion that these conclusions reflect an insufficient consideration of the advantages of composting in relation to climatic impact.

The key optimisation elements of a collection system at source for biodegradable waste are:

- An adaptation to the local context
- A different approach for kitchen and garden wastes
- A collection system as user-friendly as possible.

- ***costs***. In actual fact, continuing to selectively collect VFG would be lest costly than stopping collecting it separately. In addition, it is likely that the treatment costs will reduce further in future.
- ***outlets***. This does not appear to be a problem in the Netherlands, where agriculture and horticulture represent healthy markets.
- ***Citizens' perceptions***. The Dutch citizen is keen to be associated to biowaste management policy. If they are convinced of the added value of sorting for the environment, they are very motivated to do it. In this way, a change in policy and a step backwards could have disastrous effects on their understanding and perception.

The AOO called for independent decision at the local level for two reasons:

- in rural areas with a low population density or in very urban districts with high population density, it appears that **more flexibility** is likely at a local level; and
- it is likely that the majority of local authorities would continue to selectively collect VFG for **economic reasons.**

Note: Points 5.3 and 5.4 below do not address aspects of composting mixed municipal waste, to allow more focus on the success factors in organising selective collection systems.

5.3. Some success factors for biowaste collection schemes

In a survey undertaken by ACR + in 2000, it appeared that by then:

- 58% of organic waste (mainly food waste) were collected door-to-door
- 36% (mainly garden waste) through container parks (civic amenity sites)
- 6% through neighbourhood containers.

Separate collection for municipal biowaste can be optimised by :

- adapting it to the context within which it will be introduced, so integrating (and not adding) the biowaste collection scheme within the existing waste management system
- tackling each waste stream according to its specific features.

5.3.1. Adapting collection schemes to the local context

Efficient organic waste management requires solutions to be found which are adapted to and socially acceptable for its users. User-friendly collection systems (tailored to door-to-door or bring scheme, types of containers, frequency of collection, etc.) can enhance citizens' participation, capture rates and the quality of collected biowaste.

The choice of a collection scheme would ideally take into account:

- The type of habitat and population density;
- The climate;
- The existing waste collection system; and the development of strategies for waste prevention, management etc.

The type of habitat and population density are key elements since selective collection can be tricky to implement in highly-populated and in very rural areas. Collection in apartment buildings is often hampered by a lack of space, inadequate design of the dwellings, odour and hygiene problems posed by organic waste storage, and the inanaesthetic character of sorting structures.

Essent Milieu (the Netherlands), one of the main municipal waste management actors in the Netherlands, dealing with about 500,000 tonnes of VFG waste per year, is currently considering the separate collection of food waste in high-rise buildings. Until now, biowaste management in populated Dutch cities was unsuccessful :

- collecting about 20kg / person / year
- equalling about 33% of the maximum recoverable amount[81]
- with an impurity rate of 8%.

Economic analysis showed that a collection scheme :

- specifically focused on the capture of food waste (with the view to achieve high separation rates of around 72%)
- using small electric lorries instead of packer trucks
- and preferring above-ground collection containers
- would allow municipalities to make savings from €1-3 / tonne.

Source : Vernieuwing in GFT-inzameling and –verwerking, Relatie tussen compostfabrieken en Kyoto, John van Haeff, Manager Converteren, Essent Milieu, June 2005

On the other hand, in suburbs and in greener districts of municipalities, where inhabitants have their own garden, home composting can help to limit substantially the amount of biowaste collected. Ensuring that home composting is promoted in those areas is an option to be usefully considered by local authorities (see chapter 6).

Flanders Region (Belgium): Are you a VFG- or a Green municipality ?

In the Flanders Region (with 6 million inhabitants), a municipality belongs either to a 'VFG" area, where regular door-to-door collection is organised for vegetable, fruit and non-ligneous garden waste; or to a "green" area, where kerbside collection for garden waste only is provided regularly throughout the year (at least 4 times).

In its prevention strategy, the Flanders Region has stated as an objective that 40% of the population will have to take part in organic waste prevention initiatives by 2007, including home composting. By 2007, each municipality must have at least 6 'master composters' for each 10,000 inhabitants.

In a study undertaken by OVAM in 2001[82] , it was estimated that 36% of the population was already home composting in "green" areas, while only 24% were doing so in "VFG" areas. The authors of the study explain this difference by the fact that in "green" areas, home compositing is the only way for people to recycle their kitchen waste. The study also showed that about 30% of the population was composting at home in urban areas, while only 10% were in cities.

Climate may play a crucial role in the decision of collection frequency. Depending on temperature and/or humidity, food waste collection will take place more or less frequently, with the aim to prevent odour and hygiene problems.

Collection frequency of food waste may vary from once a week to every day in Southern areas and during summer months.

An effective collection scheme for biowaste should tend to reduce the fermentable content of residual waste, that will become less problematic to store and collect, especially in countries with warm climates.

If this is combined with an effective collection of voluminous recyclables, than this approach will over time allow for decreasing the collection frequency of residual waste.

Integration into current waste collection systems is of great importance as well. The challenge posed by the management of biodegradable waste can also represent an opportunity to rethink a new framework for a sustainable waste management system at the local level.

Some examples show that introducing a collection system for organic waste does not necessarily represent an increase in waste collection cost (see Chapter 8).

'Garden' waste
- Seasonal fraction
- Bulky fraction
- Home composting opportunities
- Easy to collect separately through a network of civic amenity sites or the organisation of seasonal door-to-door collections.

'Kitchen' waste
- Fermentable and wet fraction
- High volume mass.

5.3.2. Dealing separately with food & garden waste

There are several advantages to dealing separately with food and garden waste.

Garden waste has characteristics which makes it very different from food waste:

- a low putrescence and moisture level;
- a lower density;
- a production rate which varies during the year
- a production which varies geographically.

Lower putrescence and moisture level does not require such intensive collection patterns as food waste: green waste does not stink, does not attract pest (flies or rodents), and does not generate leachates.

A lower density: As long as garden waste is kept separate from food waste collection, these do not need compaction vehicles to achieve higher bulk densities. (Kitchen waste is very dense at 0.6kg / litre.) Therefore they can be collected with non-compacting (bulk) lorries which are much cheaper.

Garden waste presents high seasonal variations. Garden waste production significantly increases between April and October. Some municipalities organise specific collection during those periods only.

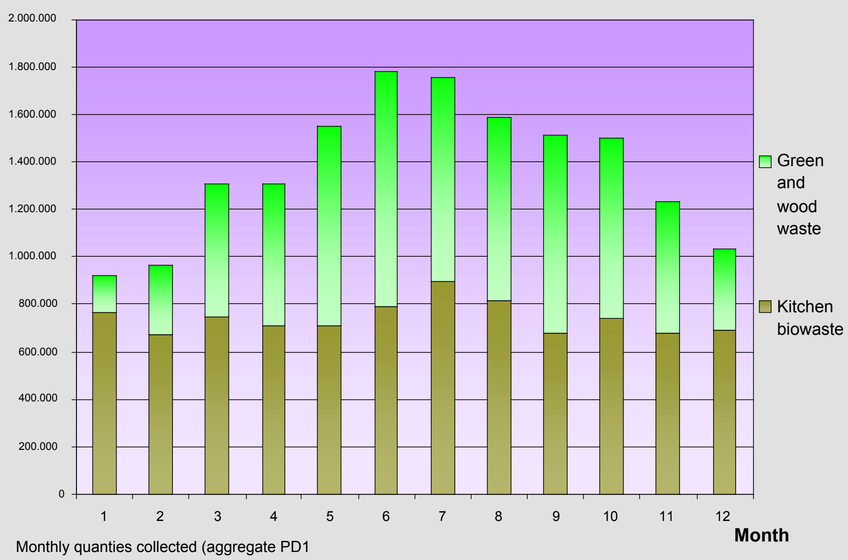
Garden waste presents high geographical variations. Its production is much more significant in suburbs and in peripheral areas than in most city centres. Collections can be restricted to these areas.

Dealing at the same time with both food and garden waste in door-to-door collection might lead to the capture of a high proportion of garden waste (up to 80-90% by weight) in the bio-bin, leading to difficulties in managing them, and in higher proportions of impurities.

Padova-1 Waste Management District (Italy): Choice of the separate management of food and garden waste

In 1996, the District of Padova-1 introduced door-to-door selective collection of food waste. Garden waste is managed primarily by home-composting, delivery at civic amenity sites, and on request (collection performed at reduced frequencies between spring and autumn). The monthly amounts of food and garden waste collected show the advantage of keeping separate the collection schemes for garden and food waste. While the monthly collection of food waste is constant (about 700,000kg / month), the garden waste amount rises between 100,000 and 1,000,000kg / month).

Figure 10 Trends for monthly collection rreen & kitchen biowaste in Padova-1 (Italy)



Source: Presentation of G. Zanon and W. Giacetti, Rome-conference (19th April 2001).

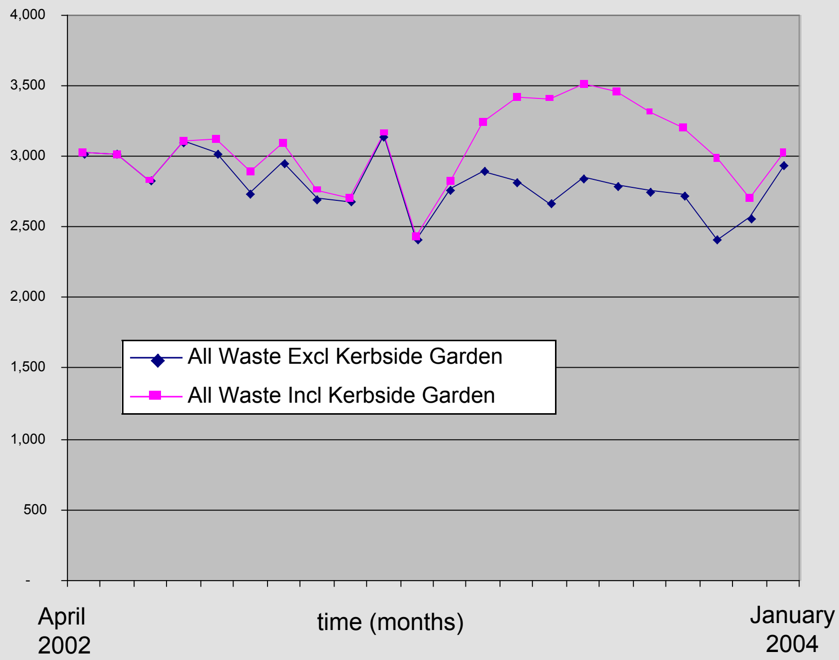
In addition to better capture rates, better quality feedstock, **specific collection tools** and frequencies for food waste may lead to reduced amounts of food stuffs in **rest waste**, meaning the latter **can be collected less frequently**.

In comparison, local authorities collecting garden waste together with one or more other fractions (cardboard and/or kitchen wastes) have seen an increase in total MSW.

Forest of Dean (UK)

In case of the recycling and composting performance of Forest of Dean (UK) here below, two quantities are plotted : the first is 'all waste collected', including all kerb-side collected waste; the second is the same plot, but minus the kerbside collected garden waste. Seasonal variations are clearly highlighted[83].

Figure 11 : Collection figures for waste, with and without garden waste collected door-to-door in Forest of Dean (UK)



5.4. Which collection schemes to choose?

5.4.1. Kitchen waste

5.4.1.1. Door-to-door systems

5.4.1.1.1. Why door-to-door systems for food waste?

Door-to-door collection of kitchen waste is often identified as the most user-friendly system and consequently enhances citizens' participation rates. For instance, analysis undertaken in Italy and Catalonia (Spain) have concluded that the purity of biowaste is much better when collected through doorstep collection schemes than by containers on the road [84].

Treviso-3 Municipality (Italy): higher purity of biowaste collected door-to-door

In Waste Management district Treviso-3 food waste was collected from 1994 to 1999 by means of wheeled bins and road containers located next to the collection containers for residual waste. The average contamination of the collected biowaste was about 13% and hence in year 2000 the district authority decided to adopt a door-to-door collection for food waste. Doing so, they reduced the impurity amount of the materials delivered to composting to 3%.

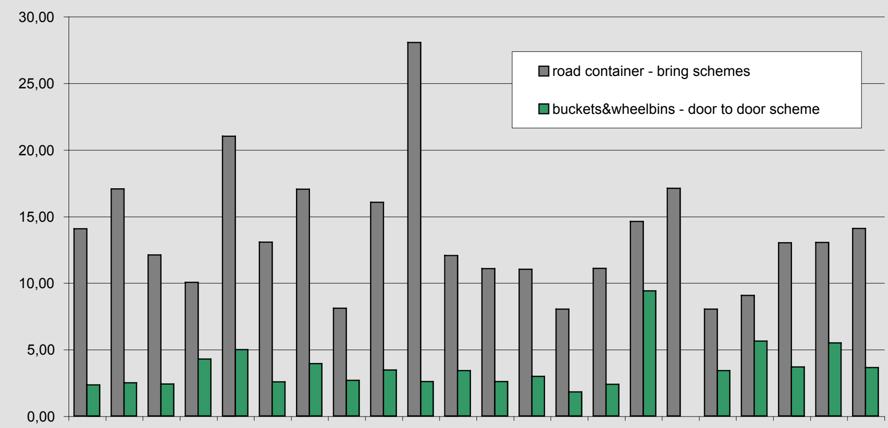


Figure 12 Food waste sorting analysis at the Treviso-3 district [85]

5.4.1.1.2. Containers

It is important firstly to distinguish between tools provided to enhance separation of food waste (which contains problematic materials such as meat, fish and cooked food) and the different types of buckets and bins used to store and deliver the materials to the collection scheme (on the kerb).

Make it easy and comfortable in the kitchen

Independently of the type of dwelling (ie. high-rise or detached) small kitchen bins (7- to 10-litre) can be provided to households in order to make it easy, clean and comfortable to separate food waste during cooking and after eating. These bins are small enough to fit into every kitchen.

Some municipalities recommend wrapping biowaste in **newspapers**. A set of bags (preferably made of compostable materials) can also help to keep the bins clean and prevents odours and leachate.

Collection scheme

For the collection scheme design, the choice between buckets, bins or bags will take into account parameters like settlement types, methods of collection, collection frequency, the possibility of checking contents of the containers, and ensuring the health and safety of collectors.

Buckets

Collection systems using buckets from 15- to 30-litres are used particularly in Southern countries. This system has proved :

- to reduce the pick-up time for each dwelling
- to prevent the inclusion of bulky materials
- to allow a fast, visual quality check of the materials delivered.

The cleanliness of the bucket is usually ensured by households themselves.

(Wheeled) bio-bins

Household bio-bin sizes vary across Europe from 80-litre to 120-litre, and they are usually stored along with the residual waste bins. For big buildings, volumes can be higher.

The cleanliness of the bin is often ensured by households themselves. Public cleansing services might also ensure that it is washed at each pick-up or only at specified frequencies (fortnightly, once a month, etc.).

The Walloon Region (Belgium) opts for the duobin

In the Walloon Region, pilots implemented in the year 2002 tested different collection options and container types.

The efficiency of separate biowaste collections varied very much (from 6kg / person / year up to 75kg / person / year). From a qualitative perspective, collection by means of duo-bins[86] resulted in better capture rates of organic waste than collections using bags.

Source : Gestion des déchets organiques - Résultats statistiques des collectes sélectives et expériences pilotes, présentation de Mme M. GILLET, Adjointe de l'Inspecteur général, Office wallon des déchets, BEST, 13 November 2003

Bags

Even when using (duo) bins or buckets, some municipalities encourage the use of **paper or biodegradable bags**, in order to :

- avoid organic content sticking to the bin or leachates escape at the bottom of the bin, thereby reducing the frequency of washings;
- prevent pests (flies, rodents); and
- allow the collection of meat and fish scraps along with vegetables and fruit residues, and thus increase the capture rates of food waste.

The use of **transparent bags** allows for the monitoring of the content by the waste collectors.

Collections using **paper or biodegradable/compostable plastics bags (made of starch)** gives the advantage of the bag not needing to be removed prior to composting - its degradation is often facilitated by shredding the bag just before the composting process. Both of them might be more expensive than classical plastic bags, but may be offset by :

- enhanced compost production; and
- reduced costs and efforts to eliminate plastic and other inert materials from the finished compost.

Biodegradable plastic bags complying with the EU standard (EN 13 432[87]) have already proven to be a useful tool in optimising kerbside collection of biowaste.

Paper bags facilitate communication with citizens. However, they can disintegrate when they get wet, and the limiting factor is that paper bags do not allow for a visual check of the material during collection.

La Villedieu du Clain (France)

Since 2004, the authority has developed a partnership with a company that makes biodegradable bags. Wishing to avoid extra costs, the city convinced the local shops (as the city does not have any big stores) to be involved in the initiative. The company agreed to replace their plastic bags with bags made of biodegradable starch. The city takes stocks management into charge to reduce the cost price, but the bills are directly passed from the producer to the retailer. Communications with the local shops have been very positive, but the project managers stress citizens' needs for clear labels.

Source: Philippe Colas working group ACR+, Nantes, 16th April 2004

5.4.1.2. Bring systems

In areas with high population densities, where limited space is available, or in the case of multi-family dwellings, bring banks / drop-off sites / civic amenity sites are often used.

Households are then often provided with bags (plastic or paper) and /or buckets to bring their food waste to neighbourhood containers. The frequency at which these containers are emptied varies, and can be increased during summer months for instance.

5.4.1.2.1. Road/ neighbourhood containers

Road containers present certain inconveniences concerning:

- the limited interception of biowaste
- the presence of contaminants

Notwithstanding, positive experiences show that it is possible to promote biowaste selective collection by means of road containers collection schemes.

City of Carpi (Italy): food waste collection using roadside containers

Roadside container collection schemes for waste are adopted by a many Italian municipalities.

Carpi is a municipality in Central-Northern Italy with 63.316 inhabitants. The municipality adopted a separate collection scheme for food waste using locked road-containers (1,700-litres - one container per 85 inhabitants), with the aim to limit impurities.

Biowaste from restaurants, coffee-shops, canteens and small enterprises is collected two times per week door-to-door .

In order to improve separation, a small plastic bin and a set of biodegradable bags (made of modified corn-starch) are given to each household, along with a key. The key is used to open the locked road-containers for biowaste collection.

These are emptied three times a week and their content is transported to the District composting plant, that also treats sewage sludge from the waste water treatment plant.

The system was successful in assuring good quality of the materials collected (impurities are about 1.5% of the collected biowaste [1]), since the locked road-containers prevent systematic fly-tipping of commingled waste.

The amount of food waste being collected separately from households is low, because participation in the scheme is not compulsory and is less of an incentive than door-to-door collection. (The authority collected about 22.5kg / person / year of biowaste from households [2] in 2003; low results if compared with average collections from best-practise schemes in Italy ranging between 50-100kg / person / year.)

Source:
[1] AIMAG Carpi, personal communication, feb. 2005;
[2] http://www.carpidiem.it/html/default/Ambiente/Rifiuti/Rapporti/index.html; data for the 1st sem 2003

5.4.1.2.2. Civic amenity sites

Amongst a range of other fractions, civic amenity sites (also called recycling centres) generally accept wastes like paper, cardboard, garden and sometimes also food waste.

The City of Camogli (Italy) selective collection of kitchen waste only at civic amenity sites

The city of Camogli, in Liguria, in Northwest Italy has streets that are too narrow for even a small truck to go through. Therefore, kitchen waste is collected at the civic amenity site.

Source: Roberto Cavallo, ERICA, Italy

5.4.2. Garden waste

Particularly in areas with high percentages of detached houses with gardens, specific collection of garden waste can enable the implementation of a system:

- less affected by **seasonal fluctuations**
- in which garden waste is managed at relatively **low cost** (through delivery to civic amenity sites or through much lower collection frequencies, run by specific "rounds")
- while allowing for the promotion of **home composting**.

5.4.2.1. Door-to-door systems

Some municipalities have set up door-to-door collection schemes for garden waste. This can help people who cannot or find it troublesome to go to civic amenity sites or have no time or interest to do home composting. They can also provide a solution to burning practices (illegal most of the time). Collections can be organised following a specific round, and with a much lower frequency than for kitchen waste (e.g. fortnightly, or monthly from April to October, or 4 times a year).

As already explained above (See 5.3.2.), too frequent doorstep collections of garden waste have led to an increase in the overall quantity of municipal waste to be collected and treated.

In Forte dei Marmi (Tuscany, Italy) for instance, a doorstep collection for garden waste achieved a rate of 462 kg/ihab./year in 1998, but also lead to a figure of 850 kg/person/year of total MSW arising [88].

Brussels (Belgium) : a green capital city

Despite the enormous urbanisation pressure, "green" spaces (that is, spaces that do not have buildings on them) cover half the surface of the Brussels Region, equivalent to an area of around 8,500 hectares. VFG waste represents one-third of the household bin, so the Region considers home composting a priority and is encouraging this activity through awareness-raising campaigns, information and training (open garden weekends, training citizens to become master-composters, financial support for neighbourhood projects, subsidised composters, technical documents on composting and worm composting, etc.). The aim is to get 10% of residents to compost by 2007.

The 3rd regional waste management plan nevertheless aims to develop a complementarity between the practice of decentralised composting and the seasonal collection of green waste, which is a good alternative for the seasonal wastes that are difficult to compost in large quantities or simply for those residents who do have a garden but who do not want to participate in home composting.

The Brussels Cleansing Agency and the Brussels Region have implemented door-to-door garden waste collections in the 8 local authorities that have the highest percentage of green spaces and the most homogenised types of dwellings. Green waste collections take place on Sundays throughout spring and summer (from May until November) with bulky wastes collected from homes on Sundays throughout autumn and winter. Residents are asked to put out their garden waste every Sunday before 2pm in specific green bags sold in shops. They find the service very convenient. In 11 other authorities in the Region, bring sites have been established where it is possible to bring garden waste during established hours which vary according to local authority.

Each annual communication campaign begins with radio spots on local radio stations for two weeks. Specific campaigns have also been developed by the Region on, for example, the collection of Christmas trees (collecting 140 tonnes per year).

Sources:

- http://www.bruxellesproprete.be
- Plan de prévention et de gestion des déchets 2003 – 2007 en Région de Bruxelles – Capitale, approuvé le 27 novembre 2003 par le gouvernement bruxellois

5.4.2.2. Bring schemes

5.4.2.2.1. Civic amenity sites

Civic amenity sites are often the main collection route for garden waste. Access rights for citizens to civic amenity sites may vary.

The advantage of sites managed by attendants is that the purity and contamination of garden waste can be reduced by advising citizens about the correct delivery and separation of materials into different collection containers.

Some local authorities can consider composting the delivered garden waste directly at the site, as some national [89] or regional legislation allow garden-waste to be composted directly at municipal collection centres, with low technical prescriptions (i.e. concrete floor, leachate collection, turning, odour controls, etc.).

5.4.2.2.2. Bring banks (or neighbourhood containers)

Garden waste can equally be delivered to bring banks, but given that the level of garden waste requires a sizeable opening these containers can also accept many types of bulky waste. This risk can be avoided using containers that limit access to residents of the district through the distribution of keys.

chapter 6

Why promote decentralised composting?

Home and community composting constitute elements of municipal waste management strategies presenting many advantages for municipalities. Indeed, they notably contribute to :

- reduce the quantity of household waste to be collected and treated by municipal services[90]
- enhance recycling rates
- educate citizens since they present the complete natural recycling process
- reduce handling costs (costs are for public relations / communications)
- allow citizens to produce their own compost for their private gardens or flower pots

Promoting home and community composting appears particularly interesting in very low density areas and in poorer countries where selective collection and/or centralised composting may appear too capital intensive.

Slovak Republic : Decentralised composting as a strategic tool for municipalities

The Slovak Ministry of the Environment considers home and on-farm composting as part of range of management options for municipal decision-makers regarding the management of municipal biowaste.

About 70% of all Slovak municipalities have less than 1,000 residents; the large number of small settlements and rural areas in Slovakia suggests decentralised composting to become a strategic tool in waste prevention and biowaste management, as well as an economically effective strategic option to combine recycling of biowaste, reuse of compost in agriculture and economical cooperation with farmers.

Source: Manual for Slovak Municipalities and Local and Regional Authorities, the Ministry of Environment, Bratislava (SK 2004).

Approaches to home composting vary across Europe:

- In Austrian regions, separate collection is only **complementary** to home composting, and dedicated to high-rise buildings, or to those who cannot compost at home.
- In many Italian cities, the promotion of home composting is **integrated** within biowaste selective collection schemes, and dedicated to garden waste.

6.1. Home composting

Home composting is the *composting of biowaste as well as the use of the compost in a garden belonging to a private household* [91].

Home composting allows the treatment of the fermentable fraction of organic household waste by means of :

- **heaps/piles** – very common in rural areas.
- **ad hoc composting bins** – the use of which is often the result of promotion actions. More common in urban than in rural areas perhaps.
- **silos or open boxes** – a rarer process. Though, the time spent by the user for its construction might reveal a real motivation for making a quality compost.

Whatever the process, the basic principles are the same as for centralised composting and some general recommendations can be made regarding :

- the use of waste of suitable composition and size
- the respect of an optimum carbon:nitrogen ratio
- optimum humidity
- regular aeration.

6.1.1. Diversion of biowaste from the municipal waste flow

There is a real lack of accurate studies on the actual proportions of biodegradable municipal waste which can effectively be diverted from municipal waste streams. Current estimates of the weight of material diverted by home composting do not seem very reliable[92] .

Some studies carried out in Germany and Austria tend to show that home composting is likely to account for 10-12% of materials that would otherwise have to be collected (separately or otherwise)[93].

In Switzerland, one third of organic waste is estimated to be composted at neighbourhood facilities or at home [94]. In a study by Adur District Council (UK, 1993) residents estimated they could divert 13 per cent of their waste through the home composting route.

The exercise also suggested that 3.2 kg per household per week was composted this way, although the University of Paisley (2001) has reported that 5-6 kg per household per week is now typical.

Padova 1 (I) waste management district measured via specific sampling a 8% decrease of MSW due to the widespread adoption of home composting [95].

Milton-Keynes County Council (UK) estimates that households performing home composting reduce their production of waste by approximately 100kg each year. This is the reason why the municipality provides its citizens with home composting bins at a reasonable price (about 17 Euros).

The bins are made from HDPE plastic produced in the Council's recycling factory. Between 1997 and October 2002, 10,000 residents bought home composting bins from the Council.

Following a study led by OVAM ("De gemiddelde Vlaming and zijn keuken- en tuinafval", Flanders, 2002), about one third (34%) of the households with a garden is home composting. Though, how much waste a family can prevent or save depends a great deal on the surface and the type of their garden.

Other waste prevention means than composting can have even more impact on the amount of waste produced. Leaving the leaves on the ground between the shrubs and perennials can save a cubic metre of "waste". And for a gardener with a vast lawn, a mulch mower is a much better investment than a compost box [96].

6.1.2. What is the quality of composts produced at home ?

Studies on the quality of composts produced at home show that these may often be too humid, insufficiently aerated when in piles, and they rarely respect phyto-toxicity standards. However, most of the time they comply with quality standards like nutrients, calcium and organic contents, and with heavy metals limits[97] .

As they are generally not commercialised, but are recovered locally, usually in ornamental gardens, their impact in terms of pollution of soils or waters is minimised [98].

6.1.3. How to promote Home composting ?

Case studies

To be successful and efficient, home composting has to be promoted to residents using a range of measures, from public relations activities to incentive pricing schemes, through the training of compost counsellors or the provision of composting boxes, etc.

The promotion of decentralised composting can appear contradictory in resorting to centralised treatment options.

In reality:

- Home and community composting make a contribution to prevention, a priority of the waste management hierarchy: they contribute not only to the diversion of certain quantities of biodegradable waste, but they also have an educational role;
- The marketing and support costs of community composting essentially relate to costs of communication and ongoing public relations (information, demonstration gardens, training of Master-Composters, etc.
- Community composting can be the main element or an accessory to a selective collection system for biodegradable waste, or can be integrated into an existing selective collection system.

The promotion of **home composting** can be delivered by very different initiatives, from information to residents, introducing a differentiated charging system, to the training of Master-Composters or providing residents with shredded green waste.

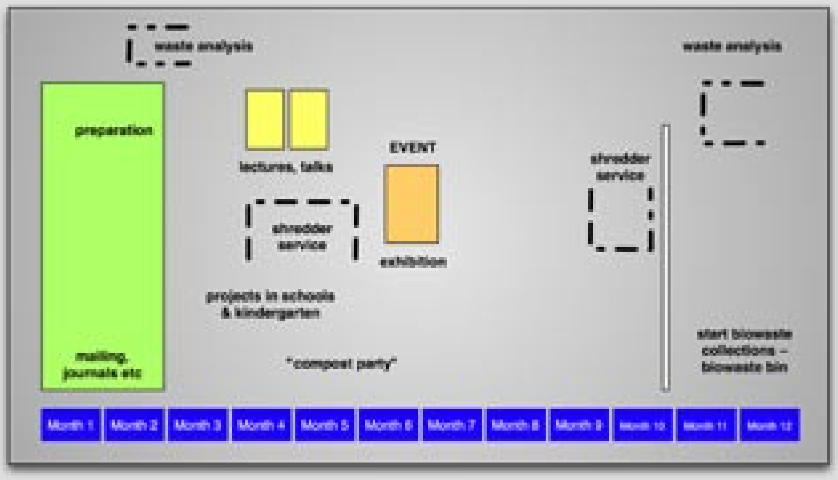
The most efficient strategies at the local level usually involve:

- regular encouragement of home composting;
- regular information (brochures, leaflets, etc.) or training courses providing methods, tools, tips, etc.;
- support with collection logistics (e.g. paper or biodegradable bags, composting boxes, etc.); and
- regular information about the value of source separation
- etc

Wolkersdorf (Austria) - an example of programme for the promotion of home composting

An example of an activity programme for educational and informational measures which took place to promote home composting in Wolkersdorf is shown below. The project lasted one year, and in this period, people had to be motivated, informed and then had to decide whether to make compost in their garden.

Figure 13 Example of programme for the promotion of home-composting (months)



Source : Handbook for the management of biowaste, Manual for Slovak municipalities and Local and Regional Authorities, 2005[99]

6.1.3.2. Master Composters

Master Composters are people trained and/or supported by municipalities or community associations to teach and support citizens in their immediate vicinity regarding all aspects of home composting and low-waste gardening. Most of the time, these people are volunteers.

IGEMO (Belgium) : thoughts on Master Composters [100]

In the Flanders region, all the municipalities are members of VLACO vzw and so benefit from the support of the Flemish Quality Assurance System for training Master Composters. The sub-regional grouping of local authorities called IGEMO (11 local authorities around the city of Malines) have been experimenting with home composting since 1997 within a waste prevention project using social, legal and financial instruments. These instruments have resulted in the reduction in four years (from 1997 to 2001) in the quantity of waste per person from 513 kg to 460 kg per person per year. After many years of experience with training Master Composters, IGEMO has proven the importance of elements such as :

- the commitment demanded by the Master Composters
- the definition of their role
- the identification of their own motivations
- the technical support of Master Composter groups
- the involvement of local authorities

This analysis has helped IGEMO to express different wishes, such as involving Master Composters in other sustainable development activities, and to look for volunteers who are available for 6 hours per month who wish to be trained in this area, and to work or to create different activities relating to specific activities. The budget required for these activities is €0.91 per person per year.

6.1.3.3. Demonstration gardens

As compost is a natural fertiliser and substrate for gardens, campaigns for home composting can also be linked to wider sustainability issues and promoted alongside wildlife gardening, the need to reduce the use of peat and of mineral fertilisers and low-waste gardening.

Association of municipalities of the Porto Region – LIPOR (Portugal) Horta da Formiga , Horta à Porta & Horta na Escola

LIPOR is the Inter-municipal waste treatment service for the Porto Region. This area of 8 municipalities has nearly 1 million inhabitants who produce about 540,000 tonnes of solid urban waste per year (about 1.5kg per person per day).

LIPOR's waste management strategy relies on the 4Rs policy: "Reduce, Reuse, Recycle, Recover", and composting has been implemented there since 1982. As communication and the participation of everyone is considered the key to the success of the waste management strategy, all LIPOR activities are coupled with efforts to inform, increase awareness and form opinions of the public about waste.

To educate and raise awareness of the population on the necessity to reduce the amount of waste produced daily, LIPOR created a **home composting demonstration site named "Horta da Formiga"** in 2002. It is a pleasant area arranged next to the new composting centre. School children and other target groups can visit and learn about composting, its advantages and different uses. In addition, an organic garden nearby grows vegetables, fruit trees and aromatic plants using the compost produced on-site. Visitors can follow a "circuit of composting", starting with the composting area, where they can see 16 different types of composting bins and choose what type is the most appropriate for them. Then come the maturation, screening and bagging of compost. Finally they walk through the vegetable garden, the orchard and the aromatic garden. LIPOR also promotes free courses in organic agriculture for teachers and adults to enhance quality of life and health by respecting nature. In 3 years, Horta da Formiga has had over 15,000 visitors.

Managers have noted that people living in urban areas without any backyards seem increasingly interested in healthier habits, food safety and especially in being able to come back to nature and to a more rural way of life. The second step was thus logically the provision of allotments to promote organic farming in a project called "**Horta à Porta – hortas biológicas da região do Porto**"; managed in partnership with the 8 municipalities and the Portuguese Catholic University 'Escola Superior de Biotecnologia'.

Through this project, LIPOR is offering residents small pieces of land (25m2), for a one year period as well as courses in organic farming for volunteers interested in producing their own vegetables, in a healthy way, without using chemical fertilizers or pesticides. So far 5 sites are run with 130 families. 350 other families are waiting for their turn. The final aim is to have sites available in the 8 municipalities of the Porto region. In 2004, LIPOR started similar projects with the aim to launch composting schemes with schools cafeterias ("**Horta na Escola"**). In addition to the provision of compost bins, LIPOR helps children to start and maintain a vegetable garden using organic farming techniques. This helps tomorrow's adults to understand how to reduce biodegradable waste and how nature provides us with fruit and vegetables.

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6.1.3.4. Incentive charging

Lower Austria (Austria) promotes home composting by incentive charging

In Austria, the Federal Government along with counties and municipalities have been developing biowaste management systems since the early 1990s, in order to implement the Ordinance on the Separate Collection of organic waste which entered into force in 1995.

The management of biowaste in Lower Austria is based on the following 3 pillars :

1. maximising home composting
2. complementary segregated collection of biowaste
3. favouring of on-farm composting.

In rural areas, home composting has become an important element of waste management: 58% of households in Lower Austria process their waste in their gardens, and in some municipalities, home composting rates are over 80%.

However, authorities are conscious that not all the households are able or willing to participate in home composting, especially in apartment buildings. For these people, the bio-bin is the only alternative.

Nonetheless, in participating in waste prevention, **home composting is promoted by a fee system which remunerates households managing their own waste:** households who do not practice home composting have to pay an additional fee for using the bio-bin system. For instance, in Wolkersdorf (see 6.1.3.1.), the yearly cost of a bio-bin is about €70.

6.1.3.5. Providing home composting boxes

Some municipalities provide home composting boxes to households, for free or at a minimum cost [101]. However, such measures should remain accessory to intensive communications activities, in order to avoid home composting boxes becoming rubbish bins or remaining unused in the back garden.

6.1.3.6. Provision of green waste shredders

Municipalities can encourage the composting of green waste by offering a shredding service to citizens. This system helps to prevent the dumping of bulky garden waste in nature or their burning in the garden. Above all, household waste usually lacks carbon elements that can provide structure to a quality compost. Therefore, one of the ways of supporting home composting is to help citizens to shred their garden waste so that they can add materials containing carbon and helping to aerate their compost, or to provide them with shredded green materials to add to their fermentable waste.

Cork (Ireland) provides residents with a green waste shredder scheme

A shredding scheme is made available to the population of Cork at certain times of the year. It is primarily operated at the Council's landfill site and at civic amenity sites where any green waste is composted.

At various times, it is made available to all of the population. After Christmas for instance, the shredder is taken to all parts of the County on designated days published in the local newspapers. Using a shredding machine which can shred trunks up to 200mm in diameter, the equipment is towed from one location to another and stored by an old disused Council's refuse collection vehicle.

The end-product from the scheme is used by the council as mulch at roundabouts and tree plantations. Currently, the activity shreds about 1,000 tonnes of waste per year (from 80 to 500 tonnes per month, depending on the season).

- Set-up costs €41 529
- Operating costs €21 /tonne

- Publicity costs €11 340
- Avoided disposal costs €12,7 / tonne

The scheme was co-funded by a grant from Ireland's structural funds (1994-1999). In less than 2 years; the savings realised through the project raised €12,700.

The regulation on peat conservation in the area is likely to increase demand for the composted material.

Source : Success stories on composting and separate collection, European Commission, 2000

ICDI (Charleroi, Belgium) provides shredded green waste to private users

As a means of promoting home composting, the sub-regional waste authority in the Walloon Region in Belgium, ICDI, allows each resident to take up to one m3 of green waste from its civic amenity sites.

Source : http://www.icdi.org/Prevention/index.htm

6.1.3.7. Complementary initiatives to home composting

6.1.3.7.1. Promoting chicken farming

Flemish Region authorities (Belgium): waste is as good as a chicken !

Chicken farming can prove to be an excellent complement to home composting, as leftovers of meals or cooked food, which are not ideal for home composters, can be an important element of food for chickens.

One chicken can 'treat' around 50kgs of kitchen waste per year, and lays eggs on a daily basis. Coupled with a compost bin, a henhouse can eliminate almost all the kitchen waste produced by a household, or around half the production of waste. This represents substantial savings for a family under differential charging for waste collection.

Many local authorities and Master Composter groups in Flanders have promoted the farming of chickens as an objective of waste prevention.

Some authorities offer their residents the possibility to buy chickens at a reduced price (from €3-8 per 20-week old chicken – usually limited to 3 chickens per family) while also delivering promotion campaigns on the advantages of having chickens in the garden, including how to help survival of disappearing species.

Through these actions, one laying chicken is offered per household. The cocks are not included in the activities, to avoid noise problems with neighbours and they are not needed for the raising of chicks.

In place of offering chickens, but in order to ensure an adequate life for them, some authorities, such as Rumst, have subsidised – for €25[102] - the purchase of hen-houses for their residents. Others, such as Sint-Katelijnen-Waver or Bonheiden have encouraged the building of sustainable henhouses.

The wood is FSC label, the protective layer is made of ecological wood, and the kits have been created in collaboration with a technical school and with a local protégé workshop.

Across the IGEMO sub-region, more than 5,000 chickens have been sold[103]. The majority of local authority environmental services also provide a 'green number' to their residents, providing community information, packed with information on how to raise chickens.

Sources :
Informatieblad IGEMO, n°21, 21 mars 2002
IVIO website : http://www.ivio.be/kippen/kippenproject.asp

An interesting complement to home composting: a chicken is capable of treating around 50kg of kitchen and garden waste per year.

6.1.3.7.2. Support in practising worm composting

Worm composting [104] is particularly interesting for schools because it allows them to use cafeteria waste for the worm bin, while also providing a variety of interesting experiments using the bin in the classroom, and can culminate in a school or classroom garden using the finished product.

California (United States)

The method seems to have very much success overseas. For instance, the California Waste Management Board has edited a guide for teachers to explore worm composting as the basis for many interdisciplinary activities.

http://www.ciwmb.ca.gov/Schools/Curriculum/Worms/

6.2. Community Composting

The size of the structuring of **community composting** initiatives varies.

In some cities, such initiatives can make socio-economic contributions through the creation of a deep interest in the management of working gardens, for example, as well as being a source of jobs.

Community composting is the *composting of biowaste by a group of people in a locality with the aim to compost their own and other people's biowaste in order to manage the supplied biowaste as close as possible to the point at which it was produced*[105].

In some European municipalities, community composting is playing a significant part in sustainably managing organic resources and source-separating both kitchen and garden waste. It can ensure that composting is carried out safely at a local level in accordance with the proximity principle.

In some cases the compost produced by groups is used in creating community green spaces or for growing food, and in some cases it is marketed back to the public and to commercial users of compost such as local authorities.

Community composting schemes range from small projects dealing with less than 1 tonne of organic waste per week to organisations with full Borough-wide contracts for service provision relating to the collection and processing of organic waste. These organisations are also responsible for providing employment and horticultural training opportunities at a local level and in many cases they also provide therapeutic training for disadvantaged people such as adults with learning difficulties.

In the UK particularly, certain conditions have facilitated this development:

- A strong community sector presence;
- The system of exemptions from waste management licensing;
- The provision of support networks for community composters;
- Funding opportunities for the development of projects; and
- Payment to groups for service provision.

East London Community Recycling Partenership (ELCRP) : Food waste pioneers in Nightingale and Landfield Estates, Clapton, London

ELCRP is operating in big estates in the Eastern suburb of London, and at the end of 2004 became the first community group in the UK to receive "positive release accreditation" for their food waste compost.

The philosophy of ELCRP's initiative is that inhabitants must be willing and have ownership of their recycling project rather than it being imposed upon them as another "deprived area improvement programme", handed down from on high. Gaining the participation of the Tenants Associations in their project was a critical factor.

Residents were supplied with a 10-litre bin with a sealable lid, corn-starch biodegradable liners and a small bag of bran inoculated with yeast/ micro-organisms. The latter allows the creation of a fermentation system stopping putrefaction. Participation rates vary from estate to estate, from 55% to 85%.

Food waste (cooked meat included) is collected door-to-door by a team of two people using adapted trolleys and who take food waste bags from the small bins, while leaving clean replacement bags for residents. Waste is then composted on-site, in a large shed containing an in-vessel composter (“The Rocket”, a well-known system in the UK), maturation bays and a range of wormeries.

The chosen in-vessel system receives an extra heat input : because of the large surface area of the small machine, one has to ensure that food waste does not cool below an acceptable temperature.

The correct nitrogen/carbon ratio is achieved by adding cardboard and wood chips. The mix is kept constantly at a temperature of 60°C and heated to over 70°C for 1 hour daily to ensure that the time and temperature requirements of the Animal By-Product Regulations are met. Afterwards, compost is matured in composting boxes or worm bins.

Full monitoring and recording of readings and batches are kept in accordance with an HACCP [106] plan. These have to be submitted to the State Veterinary Service (SVS) along with results of pathogen testing to ensure safe processing and compliance with the regulation. ELCRP has received full approval to release their compost for use.

The initiative has contributed to the reduction of bad smells, flies and rodents in the area, especially near the large bins located in the basement of each building and receiving household waste via chutes incorporated into the estate.

ELCRP also collects dry recyclables from the estates as the food waste collection, runs a second-hand / recycling shop, and has developed a green-waste composting project at a neighbouring amenity site using the compost produced in a programme of gardening and landscape improvements. Of similar importance, they create employment opportunities for the long-term unemployed or people with learning difficulties.

Sources :
Nick Mc Allister, Community Composting Network
67 Alexandra Road, Sheffield S2 3EE, UK. Tel/Fax: 0114 2580483
Email: nick@communitycompost.org. web: www.communitycompost.org

Social economy enterprises can also structure their activities around « commercial » wastes.

Villeneuve d’Ascq – France: Vitamine T

The Vitamine network is a network of social enterprises working in the North of France. Vitamine T in Villeneuve d’Ascq has a 5-hectare site dedicated to composting and market gardening. The site accepts commercial garden waste from local landscape gardeners at a €5 / m3 gate fee. This waste is shredded, windrow composted and used by Vitamine T for its market garden, where more than 30 types of vegetables are grown using organic methods.

About 300 tonnes of compost are produced per year, which is the maximum capacity allowed for an agricultural site under the French regulation without requiring any waste management licence.

Selling vegetables meets approximately 30% of the project’s total budget. Additional funding comes from providing training and from the French Government.

On an annual basis, Vitamine T creates training and employment opportunities for 40 local adults who have been long term unemployed. Trainees receive a tailored programme of qualifications through working at the project.

Les Serres des Prés
51 rue Papin
59650 Villeneuve d’Ascq, France
Tél : +33 3 20 56 58 59

Source : Growing Heaps, Community Composting Network, UK, Autumn 2004, p.14

In certain regions, the final users of compost are closely linked to the treatment method: this is the case for **on-farm composting** in Austria.

6.3. On-farm composting : the Austrian experience

In Austria today, about 350 farmers trained by professionals accept about 45% (271,000 tonnes) of the collected organic waste. This is the result of a policy aiming from the beginning at integrating agriculture into the biowaste segregated collection and composting schemes.

This has lead to a system where :

- there is complete traceability of compost products;
- the marketing of compost is not a problem;
- composting farmers are considered as the heart of an ecologically sound management of soils.

The Agricultural Composting Plants Association has also established its own Quality Assurance System (QAS). In general, an agricultural composting plant develops co-operation agreements with municipalities or waste management associations where farmers commit themselves to take a certain quantity of biowaste/green waste so long as the purity of waste is satisfactory.

Gate fees range between €40-50 / tonne for biowaste, and between €0-50 / tonne for green waste. Small plants use all the compost on their own agricultural land; bigger ones are able to successfully market a quality guaranteed compost at prices between €5 per tonne (for fresh compost to be used in agriculture in large quantities) and €20 per tonne (for fine mature compost in small quantities).

Depending on the size and the complexity of the compost facility, independent inspections and sampling analyses take place 1 to 4 times a year.

City of Graz (A): a unique cooperation model with farmers

The municipality of Graz (356,000 inhabitants) and the surrounding villages contracted a syndicate of farms that are responsible for the separate collection and pre-treatment of organic waste. In a central facility, 26,000 tonnes of separately collected kitchen and green waste is screened, shredded, separated from impurities (plastics, glass and metals), mixed and homogenised. These ready-made raw composting batches are distributed on trucks to 18 on-farm composting plants. The contracted farmers take in 200 to 3,000 tonnes according to a fixed schedule depending on their individual capacity. They run an open windrow composting and provide the necessary machinery (turning and screening machines etc.).

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

The compost remains the property of the syndicate until the compost batches concerned are certified in fulfilment with the agreed quality requirements of the Austrian Compost Ordinance. After receipt of the laboratory results the composts pass into the farmer’s possession for the 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 cooperation with the provincial Agricultural Compost Association carries out 2-4 inspections per year in Agricultural Compost Plants and takes a minimum of one compost sample for certification per year. Both parties provide full documentation and records according to legal requirements (Compost Ordinance).

Source : Decentralised composting in Austria, Florian Amlinger, Compost – Consulting & Development, Austria
http://www.biowaste.at/downloads_pdf/tpq_0212_fa_decentral-composting.pdf

Further reading:
Evaluation des politiques de prevention en matière de déchets ménagers et assimilés – Evaluation des politiques de compostage à domicile, RDC Environment pour la Région Wallonne (B), Rapport final Mars 2004.
Decentralised composting in Austria, Fl. Amlinger (Compost consulting and development Austria) http://www.biowaste.at

chapter 7

What are the management costs of household biodegradable wastes?

Viewing biodegradable waste management costs in a local context, larger than just ... biodegradable waste!

Costs not only play a significant role in the choice of the waste treatment options but an in-depth knowledge of cost aspects is essential to plan, assess, point out dysfunctions and identify optimisation margins. Evaluating and comparing costs demands local authorities to be careful and rigorous.

This chapter aims to provide a small insight into this dimension.

Generally, **municipal waste management costs are affected by a range of parameters including**:

- the local context for municipal waste management, including:
  - waste disposal legislation and standards applicable locally
  - labour costs
  - local waste management operators and local markets for waste management services
- the technical features of the waste collection and treatment system
- the level of service offered to citizens (i.e. collection method and frequency)
- the waste arisings, the targeted waste flow and the capture rates
- the administrative and educational accompaniment
- the maturity of the system and its performance.

Calculation methods and units of measurement are also determinants. Very often municipal waste management costs are expressed per tonne of waste.

Keeping an eye on different opportunities to express costs and their implications.

This can be misleading regarding the performances of the waste management system. When expressed per kilogram, the larger the quantities of waste managed, the lower the costs of the collection and treatment service.

High performing schemes might appear cheaper, and this may negatively highlight the impact of effective reduction policies. In addition, figures for a single waste flow often hide the performances of the system as a whole.

Optimisation involves integrating and matching collection and treatment options for various waste flows.

Usually, investments made in collection will generate **trade-offs on the other stages** of biowaste management. Hence the importance of assessing thoroughly :

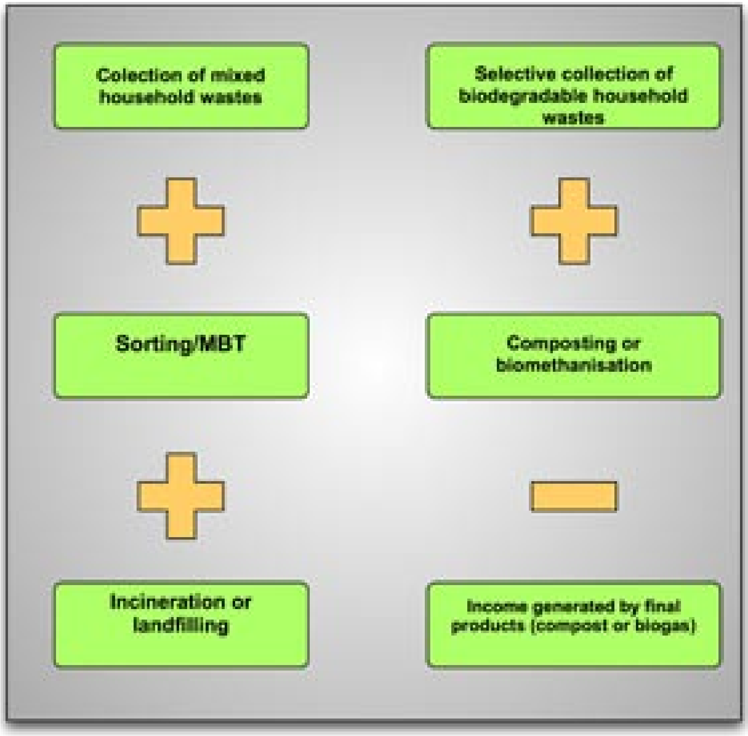
- all the costs incurred at the different stages (collection / sorting / transport / processing /and rejects disposal); and
- the potential sources of incomes (biogas, compost).

Investments made in biowaste management can also generate **trade-offs in other municipal waste flows**. For instance, separately collected biowaste is not collected with residuals, and the collection frequency of the latter can be reduced over time.

In other words, household biodegradable waste management should be designed and its costs read in the larger context of global municipal waste management costs, from collection to the final disposal.

The 2 main scenarios to be compared from an economic point of view regarding biowaste appear as follows :

SCENARIO 1 SCENARIO 2



7.1. Collection costs

A study undertaken by Eunomia for the European Commission (2001)[107] shows that residual waste collection costs in Europe can vary from €40-120 / tonne, while door-to-door collection costs for compostable materials range from €40-160 / tonne. The same report estimates that the increase in costs as a result of selective collection compared to mixed waste collection can vary between 0% and 25%.

Similarly in Belgium, an RDC study for the Walloon Region estimates door-to-door collection costs for residuals to be about €65 / tonne on average, but ranging from €85-130 / tonne for biodegradable waste [108] .

Notwithstanding these figures, some LRAs seem to have learned, through an evolutionary process, that the biodegradable municipal waste stream can be collected separately at reasonably low costs to the overall waste management system.

In particular, the resulting increase in costs due to the introduction of a door-to-door collection scheme for biowaste may be reduced taking into account the following elements :

The key optimisation elements of collection costs:

1. **The regular collection and effective interception of food waste reduces the frequency of residual waste collection**.Intensive doorstep schemes for food waste lead to high capture rates when suitably and comfortably organised for households. Consequently, the quantity of residual waste decreases, as does the percentage of food in residual waste. Odours and nuisances are reduced. Residual waste can then be collected less frequently.
2. **Collection trucks for food waste do not need compaction systems, therefore are cheaper.**
3. **The implementation of biowaste collections boosts other segregated collections (and vice-versa).** For costs comparable to those of the traditional collection of commingled waste, implementing a segregated collection for biowaste allows the creation of a new scheme giving high recycling rates and in turn allowing the implementation of other sorting schemes (e.g. paper, glass, hazardous waste).

Treatment costs for residuals influence the attractiveness of composting and anaerobic digestion.

Various studies conducted in Italy and Spain demonstrate that the introduction of door-to-door collection schemes for biodegradable waste does not necessarily result in an increase in costs.

The Table below presents an example of a cost-competitive and integrated scheme in **Tiana (Catalunya, Spain)**. Figures show that a higher cost for an intensive doorstep collection of food waste may be more than compensated for by savings made on the collection of residuals, which can be less frequent since a user-friendly system enhances citizens' participation and the capture rates of fermentable waste.

Table 13: Collection costs for Tiana, Catalonia (E)

Residual &and food waste collection	Residual + food waste (€/y)	Food waste collection (€/y)	Residual collection (€/y)	Cost per inhab/year (€)
Door to door collection (residual waste 2/wk + food waste 3/wk)	173.068	100.243	72.825	29.4
Road Containers (residual waste 3/wk + food waste 6/wk)	173.463	58.386	115.077	29.5

Source: M. Ricci, presentation at the ECN/Orbit Source Separation Workshop, Barcelona 15 – 16 December 2003

7.2. Costs of some treatment options

As with collection, national- or European-level treatment costs are often so wide-ranging that they give too broad an image. However, they may reveal policies and/or market tendencies. Comparing costs in a local context makes more sense. However, the task remains difficult because of the specifics of each local situation. Cost comparisons at the local level may however usefully be made with the objective of shedding some light on cost elements, and to understand better the differences of quality of service offered to citizens.

7.2.1. Influence of landfill and incineration costs

Incineration and landfill costs vary significantly across Europe as the table below illustrates.

Table 14: Landfill and incineration costs in some European countries[109]

	Landfill costs (incl. tax, € / tonne)	Incineration costs (incl. tax, € / tonne)
Austria	110	97-324
Belgium	45-100	85-100[110]
Germany	35-(220)[111]	65-250
The Netherlands	107-164	70-135
Portugal	6-15	46-76
Spain	25-35	34-56

Obviously, in countries like Germany or Austria, they have created a context that makes separate biowaste collection and treatment more attractive than in other countries, where disposal options remain cheap.

However, landfill and incineration costs are likely to increase in Europe, following the development of the European waste policy and the implementation of the landfill[112] and incineration [113] directives.

7.2.2. Composting and AD costs

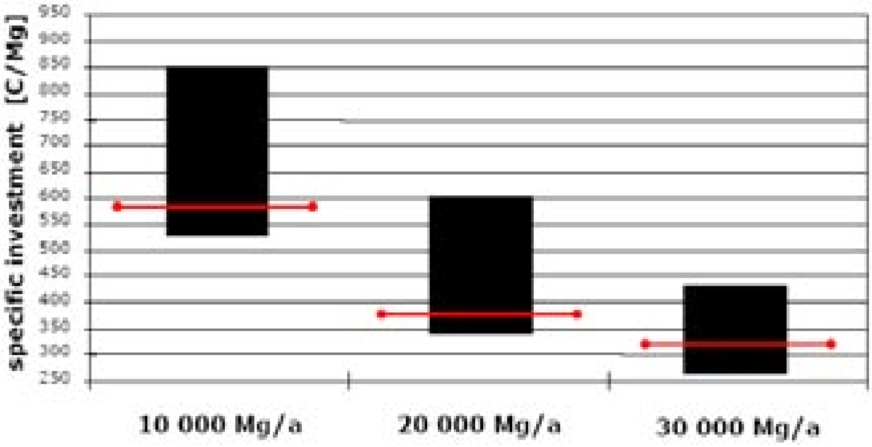
Waste treatment plants in general induce two broad categories of costs : those related to investments (capital costs) and those related to the running of the plant (operating costs).

7.2.2.1. Capital costs

Capital or investment costs are determined by factors such as the plant size and engineering, its location, and waste composition. These costs are also intrinsic to a given project.

For instance, AD plants treating MSW must organise pre-treatment infrastructure, which can have different requirements for segregation, in accordance with the goals of the project (production of combustibles, high quality digestates, etc.).

Figure 14: Investment costs for AD plants [114]

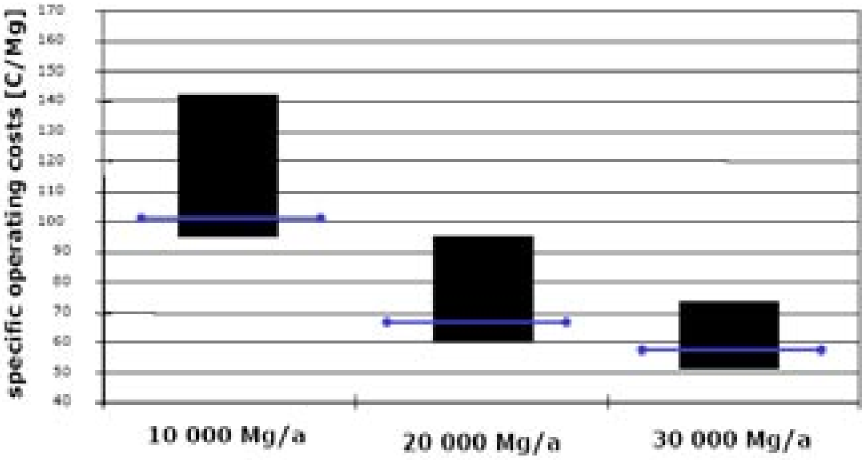


Whatever the process, investment costs per tonne of waste are inversely proportional to the size of the plant.

7.2.2.2. Operating costs

Operating costs include staff, insurance, transportation, licenses, pollution abatement and control, maintenance, etc.

Figure 15 Operating costs for AD plants [115]



The quality of the product will have a positive influence on its price.

As for investment costs, operating costs per tonne of waste decrease when the size of the plant grows.

7.2.2.3. Importance of sizing and location

The sizing of an installation does not only have to consider the quantity of waste to be treated, but also needs to consider the types of waste, the needs of the users and the outlets existing on the territory.

It can sometimes prove to be more relevant to create many small treatment sites with a view of distributing the products to local users, which reduces transport costs and assists the development of a relationship of trust.

7.2.2.4. Review of some biowaste treatment costs in Europe [116]

Composting is a natural way to manage biowaste. Open air windrow composting can cost less than €20 per tonne. It might however not be appropriate for kitchen waste for instance, or more fermentable waste, according to local regulations.

Table 15 Centralised composting (open windrow)		
Approach of average costs of biowaste (EUR/t)		
Europe	20 - 45	(Eunomia, 2000)
	16 - 35	(AEA, 2001)
Netherlands	20 - 40	(AOO, 2002)
France	34 - 79	(Ademe, 1998)
Belgium	30 - 80	(Indaver, 2003)

Table 16 Centralised composting under closed hall		
Approach of average costs of biowaste (EUR/t)		
Europe	54 - 90	(Eunomia, 2000)
	50 -174	(AEA, 2001)
Netherlands	60	(AOO, 2002)
France	48 - 95	(Ademe, 1998)
Italy	40 - 65	(SAPM, FareVerde 2004)
Belgium	70 - 80	(Indaver, 2003)

Table 17 Centralised Anaerobic Digestion plant		
Approach of average costs of biowaste (EUR/t)		
Europe	50 - 140	(Eunomia, 2000)
	80 - 110	(AEA, 2001)
Netherlands	22 - 50	(AOO, 2002)
France	53	(Miquel, 1999)
Belgium	55	(Indaver, 2003)

7.2.3. Revenues generated from compost

Revenues generated from compost are influenced by both the quality of the compost and local market prices. Market prices depend on the offer/demand ratio, while product recognition is largely influenced by customers' trust.
The compost plant "Kompostwerk Warendorf GmbH" of Ennigerloh in Germany produces different categories of compost going from:

- €16 per m^3 for basic compost categories provided in bulk,
- to €4 per 45-litre bag (or €88 per m^3) for substrates of specific plants.

Table 18 Compost marketing hierarchy indicating market prices and volumes[117]	
Compost segment	**M3 value**
Agriculture	EUR 0 - 3
Reclamation	EUR 0 - 4
Wine and fruit	EUR 1 - 6
Organic farm	EUR 2 - 6
Private gardens	EUR 5 - 20
Top soil mix	EUR 10 - 15
Landscaping	EUR 10 - 20
Nurseries	EUR 10 - 30
Sports turf	EUR 15 - 40
Greenhouses	EUR 20 - 40

The compost plant "Kompostwerk Warendorf GmbH" of Ennigerloh in Germany produces different categories of compost going from:

- €16 per m3 for basic compost categories provided in bulk
- €4 per 45-litre bag (or €88 per m3) for substrates of specific plants

Source : Remondis ®

7.2.4. Revenues from biogas

The biogas produced from AD plants is often used for their functioning, as heat and electricity. These savings in energy vary from installation to installation, in relation to the composition of biogas produced. The sale of biogas to the electricity network or of local gas is relatively complex and varies according to country. For this reason, we do not detail the revenues from biogas.

Further reading:

- Economic analysis of options for managing biodegradable municipal waste, Final report to the European Commission, Eunomia Research and Consulting et al, 2002
- Hogg, D et al. Costs for Municipal Waste Management in the EU, Final report to the DG Environment – European Commission, 2002
- Hannequart, J.P., and F. Radermaker, Methods, costs and financing of waste collection in Europe – General review and comparison of various national policies, ACR+, 2003
- Bartelings, H. Municipal solid waste management problems: an applied general equilibrium analysis, Wageningen, 1st December 2003
- Cost consideration of separate collection and treatment of biowaste, compared with a joint disposal of bio- and residual waste, INFA, Final report for Verband der nordrhein-westfalischen Humus- und Erdenwirtschaft e. V., November 2004 http://www.payt.net

chapter 8

What are the potential tools for an integrated biowaste management strategy at the local level?

Some cities and regions in Europe have succeeded in creating a high-performing framework for the management of their biowaste, demonstrating a political will to promote sustainable biodegradable waste management with or without a supportive national context.

Some measures, sometimes even not directly linked to biodegradable wastes, can nevertheless help in their good management, and contribute to their efficient integration in a larger framework of municipal waste management.

Various integration tools can be identified, such as:

- in relation to the flows – it is appropriate to consider all the wastes together to see where the synergies can be for their collection or treatment; while preserving the quality of the biowaste management chain and avoiding to dilute pollutions;
- supporting measures (economic, legal and educational) for the management of biodegradable wastes.

8.1. Creating synergies with non-household biowaste

8.1.1. The HORECA[118] sector

Biodegradable municipal waste also includes residues from fruit and vegetable markets, from the HORECA sector (hotels, restaurants and catering) or from other commercial sources, to the extent to which they are managed by the municipalities' waste management services.

OVAM (Belgium): "Clean kitchen (Keukenschoon) project"

The total quantity of wastes and remainders from kitchens in the HORECA sector in Flanders is close to 100,000 tonnes per year. The project 'Keukenschoon' (Clean Kitchen) aims to raise awareness in this sector of the selective collection of these wastes, and of the reduction of volume in industrial wastes. According to Flemish regulation relating to waste management (VLAREA), it is not obligatory to collect biodegradable wastes separately from shops and businesses. However, for these actors, it is more interesting to sort this fraction for economic as well as for legal and technical reasons (due to landfill bans of organic wastes).

In 2001, the 'Clean Kitchen' project was launched by the Flemish Province of Brabant, with a number of partners. The pilot project aimed to examine over 3 months the HORECA sector kitchen wastes to assess the possibility of selectively collecting their wastes for composting. The results of the project were very positive:

- Sorting these wastes at source was possible under clear sorting rules, with a density of collection points and with consistent logistical means as well as with a regular follow-up. It takes time to change behaviour in kitchen teams.
- The ability of collectors in relation to logistics is essential to guarantee the user-friendliness of the systems.
- Composting of this type of waste requires a more sustained attention (recognising their higher fementability).
- The economic advantages are clearly obvious as collection costs are based on weight, and not on volume.

The positive results of this pilot project resulted in the follow-up of the Province (with the participation of more than 200 HORECA companies) and the implementation in other Flemish cities.

In 2002, around 1,400 tonnes of HORECA sector wastes were collected and composted in Flanders.

Beyond the household biodegradable fraction, it is worth considering at the same time mixed waste and the treatment synergies that are possible, while trying to maintain the quality and sustainability of the end-product.

Whatever the treatment type used, the quality of the incoming material determines the smooth running of the process. The choice of technology can support the optimisation of the process, but it can **never solve quality defects or the degree of contamination of incoming materials.**

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LIPOR[119] (Porto, Portugal) : an integrated strategy for the selective collection of biodegradable wastes

LIPOR is the company responsible for the management of urban wastes produced by 8 local authorities making up Greater Porto. Since October 2004, a composting centre with a capacity of 60,000 tonnes per year has been receiving organic wastes collected selectively.

The selective collections are progressively implemented according to 4 large organic waste flows:

- Gardens, parks, and cemeteries
- Restaurants and canteens (from schools, hotels, and industries)
- Markets and large producers
- Houses (door-to-door collection)

Restaurants and canteens

- identification of all the restaurants and canteens (schools, hotels, etc.) in each municipality
- delivery of surveys (service type, separation of wastes, waste production, etc.)
- delivery of communications campaigns (information provision, awareness-raising, etc.);
- distribution of containers of 50- to 240-litre for selective collection;
- organisation of specific collection rounds
- creation of a toll-free number for any questions.

More than 250 restaurants and canteens participate in the system, which are closely supported by the LIPOR teams.

Markets and big producers
The implementation of organic waste selective collection systems for markets and big producers (fruits, vegetables, distributors of food products, etc.) is still in development according to individual discussions. Closed containers of 800-litres and $15m^3$ sizes are made available by LIPOR.

Door-to-door selective collection
This is still in development, with buildings that are designed with a room for waste storage as a priority. In this case, LIPOR provides them with 140-litre or 360-litre bins and 10-litre buckets for residents. The project already covers more than 17,000 residents (270 buildings). Collections take place 3 times per week, and are the object of an intensive communications campaign aimed at residents.

Green waste
These wastes are accepted at 22 eco-centres (civic amenity sites), and specific collection rounds are also undertaken for certain private companies and for the municipalities. LIPOR has also developed a project to collect the wastes from cemeteries to be treated at the composting centre.

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8.1.2. Sewage sludge

Some municipalities have decided to manage and recover **sewage sludge** along with municipal solid biowaste, through "integrated municipal waste management schemes".

Leoben (Austria): synergies between kitchen waste and sewage sludge

The residents of Leoben generate around 161kgs of biodegradable household waste per year. 38% of these wastes are collected selectively, 36% are composted at home, and the rest can be found in residual waste.

The green waste collected in the periphery of the authority are composted in open air windrows, and those biodegradables collected selectively from the centre of town are sent to the AD plant along with sewage sludge. The addition of biodegradable solid waste to sewage sludge improves the energy production of the AD plant, creating savings in treatment costs.

Source : Alfred Krenn, Head of department of waste and wastewater management, City of Leoben, presentation made in Brussels on 5th July.

8.1.3. Livestock manure and industrial biowaste

In rural areas, **manure** can be treated together with biowaste – and not only through on-farm composting. For instance, the biogas plant of the city of Odense (Denmark, 186,000 inhabitants) uses both manure and biowaste. The digestate is sold as soil fertiliser, while the energy and heat are distributed to the public of electricity and heat grid [120].

City of Aalborg (DK) : synergies created around Anaerobic Digestion

The anaerobic digestion plant of another Danish city, Aalborg (DK, 160,000 inhabitants) accepts biodegradable household waste sorted at source, as well as separately collected biowaste from about 350 canteens, supermarkets and restaurants, as well as industrial waste from fish industry and slaughterhouses, and manure from the 16 farmers who own the plant.

The initiative received funding from the ALTENER programme (DG Energy and Transport, EU Commission).

Even if the biogas plant only receives 3 to 5 tonnes of household biowaste a day currently, the capacity can be extended up to 10 to 15 tonnes, and can create in the medium-term an incentive for generalising biowaste selective collection in the different districts of Aalborg.

Source : http://europa.eu.int/comm/energy/res/publications/doc2/EN/AALBO_EN.PDF

8.2. Regulatory, economic and fiscal tools

8.2.1. Legal measures

Many municipalities in Europe have to comply with national regulations banning the landfilling of biowaste, or are obliged to separately collect this waste stream, or to set targets for the recovery of biowaste.

8.2.1.1. Bans on the landfilling of BMW or on specific fractions of BMW

In **Denmark**, wastes which are suitable for incineration have been banned from landfilling since 1997.

Some measures, at times not directly linked to biodegradable waste management, help to effectively integrate it into a wider framework beyond municipal waste management. This can involve legal measures (landfill bans, mandatory separate collection or objectives in recycling/composting, etc.) or economic or fiscal incentives.

In the **Netherlands**, biodegradable wastes are banned from landfilling since 1995. In **Flanders,** separately collected food and garden waste and municipal waste from households have been banned from landfills since 1998, as well as the combustible residual fraction of sorted household waste (maximum TOC - total organic carbon – of 6%).

In **Austria**, only waste with a maximum TOC content of 5% may be landfilled. This means that biodegradable waste must be pre-treated before going to landfills.

In **Germany**, the Ordinance on the Landfill of waste provides that by 1st June 2005, municipal waste may be disposed in landfills if the maximum TOC is not more than 3%. As this would necessitate a thermal treatment of the waste, biowaste subjected to mechanical biological treatment are allowed to be landfilled if their TOC does not exceed 18%.

Beyond Europe-25: Norwegian local authorities move to end all biodegradable waste dumping

Norway is about to implement a strategy banning all biodegradable waste from landfills by mid-2009. Paper, wood, textiles, food and sewage sludge would be covered by the ban, which is in line with the Government's target - also for 2009 - to recycle 100% of all such waste [121].

The "socio-economic utilitarian value" of a total ban on the dumping of biodegradable waste in Norway has been estimated to total €24m-133m between 2005 and 2016. It will also halve methane emissions and cut pollution from leachates, while boosting district heating generation. The anticipated cut in methane alone would be the equivalent of a 40% reduction in greenhouse gas emissions from road traffic.

8.2.1.2. Mandatory separate collection schemes for biowaste

This kind of obligation may be put on municipalities by central or regional governments.

Examples :

Netherlands	Since 1994, municipalities are obliged to separately collect food waste, garden waste and paper and cardboard from households. This obligation was reconsidered at the end of 2004, but maintained with more room for manoeuvre for LRAs.[122]
Austria	Since 1995, municipalities are legally required to separately collect and treat organic waste from households. Citizens themselves are required to sort their biowaste..
Catalonia (Spain)	Since 1999, municipalities with more than 5,000 inhabitants must separately collect the organic fraction of municipal solid waste.
Denmark	Municipalities are obliged to collect 55% of newspapers and magazines for recycling. Specific collection systems must also be established for canteens and restaurants which generate more than 100kg of food waste per week, and for the biodegradable fraction arising from supermarkets.
Venice (Italy)	Since 2003, municipalities that do not reach the minimum recycling targets (35%) defined by the National Law on Waste, are required to introduce a separate collection for food waste from households

8.2.1.3. Composting and recycling targets

The Ronchi Decree in **Italy** established a recycling/composting target of 35% for municipal waste by March 2003, which prompted LRA initiatives for the recovery of the biodegradable fraction.

In the **UK**, English authorities are to help achieve Landfill Directive targets through statutory targets aiming to achieve a combined recycling and composting rate of

33% of household waste by 2015 (with intermediary targets of 25% by 2005 and 30% by 2010). In Wales, the target is 40% recycling and composting of municipal waste by 2010 (with a minimum of 15% from composting). Scotland has set municipal waste targets of 35% recycling and 20% composting by 2020, and Northern Ireland has set a target for household waste of 25% recycling and composting by 2010.

Finland has established a target of a 75% capture rate of biowastes by 2005.

8.2.2. Economic and fiscal incentives

8.2.2.1. Economic incentives for LRAs to limit or avoid waste landfilling

A **Landfill Allowance Trading Scheme**[123] has been launched **in England** on 1st April 2005. The scheme allocates tradable landfill allowances to each authority, at a level allowing England to meet its contribution to the UK targets under the Landfill Directive. An authority which does not have enough permits to cover the amount of Biodegradable Municipal Waste (BMW) it intends to landfill would need either to increase its rate of diversion, purchase additional allowances or borrow up to 5% of its following year's allocation. Authorities can choose to meet their targets alone or by cooperating together; should they not need their allowances, they can sell them or bank them with some restrictions.

In **Belgium**, the Walloon Region introduced in 1999 a taxation system which aims to limit the quantity of untreated wastes generated by the local authorities in the Region.

Walloon Region (Belgium) :
creation of waste production quotas for municipalities

In 1999, a tax was introduced in the Walloon Region on authorities that consolidate, recover or eliminate a certain quantity of unsorted household wastes per inhabitant.

These quantities progressively evolved from 270 kg per person in 1999 to 240 kg per inhabitant in 2002. The level of the tax evolved alongside from €27.50 to €35.00 per tonne since 2002.

This tax is paid by the local authorities to the Region and serves to fund the management of the wastes generated.

8.2.2.2. Application of the Polluter Pays Principle in financing municipal biowaste management

Source separation schemes for dry recyclables and BMW should help to reduce the amount of putrescible materials in residual waste; hence effective recycling schemes allow waste producers (i.e households and others) to deliver their waste with reduced bin-size and demand for lower emptying frequency for residual waste. The performance of source separation schemes for biowaste can also be enhanced by the setting up of "pay-as-you-throw" (PAYT) charging systems .

How the Flanders Region (Belgium) generalised a PAYT scheme including biowaste

The Flanders Region developed a policy that actively promoted the application of the Polluter Pays Principle, which partly translated into putting responsibility onto anyone putting products onto the market. This producer responsibility related specifically to packaging waste, waste electrical and electronic equipment, batteries, medicines, end-of-life vehicles, paper, and tyres.

The other constitutent of this policy related to putting responsibility on the citizen for the collection costs for actual quantities produced. However, the direct repercussions of these costs are not practicable for selective collection. Such a mechanism does not allow indeed the development of a financial policy that can promote positive behaviour as is wished.

In actual fact, almost all the Flemish authorities have resorted to a system of 'pay as you throw', whether for bags or bins. The encouragement of selective collection depends on charging for bags for residual waste at a rate higher than those bags for selective collection, but these are not always free for households. In this way, prevention and home composting are promoted.

The analysis of the charges set by the local authorities in 2000 have shown the following results:

- 96% of local authorities charge for residual household waste, with a 60-litre bag being most popular. The average cost for the bag is €0.66 (between €0-1.50)[124] and holds 7-8kgs of wastes. As incineration costs amount to a minimum of € 0.12 per kg, OVAM (the regional waste management administration) considers a charge of €1 per bag as a minimum.
- Two-thirds of local authorities (66%) charge for the collection of green waste. Households pay an average of €30 per year for 26 collections. The average cost is €0.50 / bag (between €0.25-0.90 per bag).
- The average charge for dry recyclables (plastics, metals and drinks cartons) is €0.15 per bag (from €0-0.60).

8.2.2.3. Markets developments for products

Overall marketing activities can advantageously be supported by regional and national Governments and municipalities.

Markets and outlets for the recyclable fractions must be clearly identified in advance, as they will condition :

- **the manner in which waste is separated and collected**, highlighting quality standards to be achieved and thus the quality of the secondary materials to be provided
- **the options for treatment.**

It is relatively difficult to positively market in the long-term something which is considered a waste. Markets must be developed together with the production of compost and with the development of source-separation initiatives in order to ensure that the demand does not run behind the supply and that niche markets for higher-valued products are developed progressively.

How a LIFE-project helped to promote compost in Andalusia Region (Spain)

The regional waste management plan of the Andalusia Region sets an objective of 95% treatment of all waste generated by 2008.

With this purpose, the Environment Ministry of the Regional Government of Andalusia (Consejería de Medio Ambiente) has built eight recycling and composting plants in the past five years, and initiated programmes to promote the production and use of quality compost.

There are now 18 recycling and composting plants operating in Andalusia. These plants treat approximately 2,300,000 tonnes a year of domestic municipal waste, which represents 75 % of the domestic municipal waste generated in Andalusia. Four other plants are currently being built, which will allow to treat more than 3,000,000 tonnes a year.

The Project LIFE-Environment "*Co-composting procedures and its product application on afforestation, landscaping, and forestry and agricultural crops in the Andalusia region and Portuguese Algarve*", aimed to promote the validity of compost from municipal waste as an organic slow-release fertilizer or soil improver, and to provide a solution for two challenges to be met by Mediterranean farmers : low organic matter levels in soils, and soil erosion.

The project tested composts made from different materials (municipal waste, sewage sludge, green waste, etc.) which were treated by open-windrow composting. With a focus on awareness-raising of various actors, and on the exchange of information about (co)composting and compost applications, the project was communicated by a range of partners and specific media tools including several workshops, a technical compost guide and a website: www.compostandalucia.net.

The former LIFE office of the project has now been transformed as an Andalusian Compost Advising and Control Office whose tasks include: publication of catalogues and educational materials and guides; the creation of an association of quality compost producers; continued organisation of demonstration sites; promotion of home composting; encouragement of composting of agro-industrial materials; and promotion of the compost in the region.

More information : forolife@egmasa.es
www.compostandalucia.es

8.2.2.4. Subsidies for the use of compost

In Mediterranean areas, LRAs are increasingly implementing programmes and subsidies to promote the use of compost as an organic improver. The main provisions relate to :

- funding to farmers for compost used per unit area [125]
- tenders for green public areas including a specific preference for composted products; and
- funding to farmers when replacing their old machinery by a new one suitable for compost spreading.

Piedmont and Emilia Romagna Regions (Italy) grant subsidies for the use of compost

Some Italian Regions are subsidising farmers in the application of organic fertilisers and compost on depleted soils (with a minimum concentration of organic matter) in order to restore organic matter to soils and to maintain soil fertility. These funds are created within the scope of the Rural Development Plans (2000-06) (Reg. CE 1257, on sustainable agriculture). The funding varies from case to case:

- for some years now, funding in the Emilia Romagna Region ranges between €150-180 / hectare to use compost and promote a build-up of organic carbon in depleted soils;
- the Piemonte Region pays €220 / hectare to use up to 25 tonnes of dry matter in depleted soils over a 5-year timeframe in order to allow for crop rotation.

Such grants might constitute a precedent, when it comes to environmental policy-making and economic instruments that drive agronomic practices – and the related waste management practices - towards a more sustainable approach under the scope of climate change issues and soil fertility.

chapter 9

Conclusion

The regional, and all the more so the local, contexts of biodegradable household waste management are very contrasting according to point of view:

- Types and quantities of wastes generated
- Existing institutional and legal framework
- Availability of treatment options
- Potential outlets for the recovery of biodegradable wastes.

This multiplicity of local situations calls for a diversity of responses and implementation techniques.

It only remains to adopt a biodegradable waste management strategy that obligates local authorities, even if this brings some risks. In effect, the investments that figure are important, and they engage local authorities in a relatively long-term thought process (20 to 30 years) and the performance of systems put in place cannot be valued until they achieve a certain degree of maturity.

Therefore, the cities and regions of Europe need a stable environment, and incentives at the European level that are certainly desirable in encouraging a harmonized development of measures at the European scale.

The European framework defining quality requirements for composts is relatively uncertain at the moment. The project of establishing a directive on the subject seems to have been temporarily abandoned despite many calls from a coalition of actors assembling private actors as well as NGOs [126], particularly asking for the establishment of objectives of separate collection of certain fractions of green waste and biodegradable households waste.

Compost standards could be proposed in annexes of the Framework Directive on Waste which is still under revision, and other aspects considered under the IPPC Directive and within the thematic strategy for the protection of soils [127]. It only remains that the level at which standards could be fixed is also essential: we hope that it will guarantee a quality sufficiently elevated to satisfy users' needs, that permits the development of markets for compost at the level of the Europe-25, and to help the soils that are in need of organic content.

Our European ecosystem depends on it.

The regional situations are very different, but incentives at European level are obviously desirable to encourage the harmonised development of measures across Europe.

Publications of interest

Decision makers guide to solid waste management, EPA Washington, 1995
http://www.epa.gov/epaoswer/non-hw/muncpl/dmg2.htm

Among a serie of ADEME guides :

- Le compostage des déchets organiques des ménages en Allemagne, synthèse générale, ADEME, Octobre 1999.
- La valorisation des biodéchets ménagers en France, ADEME, Mai 2000.
- Collecte sélective et traitement biologique des biodéchets des ménages, Vol. 1 et 2, ADEME, Avril 2001
- Qualité et biodéchets~: les systèmes de gestion européens, ADEME, Juin 2001
- La gestion de proximité des déchets organiques, ADEME, Mai 2002.

Successful stories on composting and separate collection, European Commission, DG Environment, 2000

Le traitement biologique des déchets organiques, Cercle National du Recyclage, Décembre 2000.

The organic waste flow in Integrated Sustainable Waste Management, Tools for Decision-makers, Experiences from the Urban Waste Expertise Programme (19995-2001), Nadine Dulac, WASTE 2001.

Guidelines for Municipal Solid Waste Management in the Mediterranean Region, Medcities and ISR (EWC), Barcelona, 2003
http://www.pap-thecoastcentre.org/publications-pa-waste.html

High diversion of municipal waste : is it achievable ?, David Davies Associates for Resource Recovery Forum, 2004

Handbook for the management of biowaste, Manual for Slovak municipalities and Local and Regional Authorities
PHARE Twinning light project, E. Favoino and M. Ricci (Scuola Agraria del Parco di Monza), D. Hogg (Eunomia Consulting), 2005

Proposals for economic instruments and financing mechanisms in support of a biowaste strategy, Report to the Ministry of the Environment Slovak Republic, PHARE Twinning light project, E. Favoino and M. Ricci (Scuola Agraria del Parco di Monza), D. Hogg (Eunomia Consulting), 2005
http://www.biowaste.at/downloads_pdf/cup_050602_sk_econ-instruments.pdf

Projet de Guide pratique à l'attention des élus locaux – «Valorisation des déchets organiques~: comment mettre en place vos débouchés?», AMORCE, Mai 2005

Advanced Biological Treatment of Municipal Solid Waste, Enviros Consulting Limited on behalf of Defra (New Technologies Supporter Programme), UK 2005

Websites

http://www.biowaste.at
http://www.compostnetwork.info/ (European Compost Network)
http://compost.org.uk

Glossary of terms and abbreviations

Remark :

Most of the terms used have the same meaning as in the European Commission's Working document "Biological treatment of biowaste" from 12th February 2001[128] . Perhaps these definitions do not benefit from a common agreement, but they seemed to be the most elaborated ones taking into consideration practice, technologic evolutions, and the will to promote sustainable household biowaste management.

anaerobic digestion (AD)	the biological decomposition of biowaste in the absence of oxygen and under controlled conditions by the action of micro-organisms (including methanogenic bacteria) in order to produce biogas and digestate[129]
biodegradable waste or biowaste	any waste that is capable of undergoing anaerobic or aerobic decomposition, such as food and garden waste, paper and paperboard [130] However, given that recycling appears to be a better option than composting or AD for paper [131], it does not feature as an element of our more in-depth analysis in this document (see Point 2.3.). In this report, the term "biodegradable" has often been preferred to the term "organic", because strictly speaking the latter refers more to the general carbon chemistry. Though we consider both as synonyms.
Biodegradable household waste	Food and green waste created by households.
catering waste	All waste food originating in restaurants, catering facilities and kitchens, including central kitchens and household kitchens[132].
Civic Amenity Site (CAS)	Or container park
compost	the stable, sanitised and humus-like material rich in organic matter and free from offensive odours resulting from the composting process of [separately collected] biowaste, [which complies with the environmental quality classes of Annex III] [133]
composting	the autothermic and thermophilic biological decomposition of [separately collected] biowaste in the presence of oxygen and under controlled conditions by the action of micro- and macro-organisms in order to produce compost.[134]
community composting	the composting of biowaste by a group of people in a locality with the aim of composting their own and other peoples' biowaste in order to manage the supplied biowaste as close as possible to the point at which it is produced.[135]
digestate	the material resulting from the anaerobic digestion of separately collected biowaste[136]
EEA	European Environment Agency
food waste	The mixture of both cooked and raw materials left over after the preparation and consumption of human food[137]
Green waste	Biodegradable, compostable wastes created in gardens, public parks or orchards. Green waste is composed of branches with a diameter of less than 10cm, vegetable residues, hedge trimmings, leaves, and grass. They can be produced by households, environmental services, gardening companies, etc[138]
home composting	the composting of the biowaste as well as the use of the compost in a garden belonging to a private household[139]
household solid waste	waste generated by the daily activity of households[140]
in-vessel composting	the composting of biowaste in a closed reactor where the composting process is accelerated by an optimised air exchange, and control of water content and temperature [141]
LRA	Local and Regional Authority
mechanical -biological treatment (MBT)	the treatment of residual municipal waste unsorted waste or any other biowaste unfit for composting or anaerobic digestion in order to stabilise and reduce the volume of the waste[142]
municipal waste	definition of Directive 1999/31/EC address the nature of municipal waste : these are "waste from households, as well as other waste which, because of its nature or composition, is similar to waste from household[143]The UNEP/UNSD definition of municipal waste [144] adopts sources of municipal waste as an angle of view : it includes (...) waste originating from: households, commerce and trade, small businesses, office buildings and institutions (schools, hospitals, government buildings). It also includes waste from selected municipal services, e.g. waste from park and garden maintenance, waste from street cleaning services (street sweepings, the content of litter containers, market cleansing waste), if managed as waste. This definition excludes waste from municipal sewage network and treatment. Other definitions stress the role of the local authority : municipal wastes are wastes produced by residential, commercial and public services sectors, that are collected by local authorities for treatment and/or disposal in a central location[145]
Neighbourhood containers	Containers, placed at roadsides or in areas where there is pedestrian traffic, such as supermarkets, and which serve to collect or or many types of specific recyclable materials[146]
on-site composting	the composting of the biowaste where it is generated [147]
RDF	Refuse-derived fuel
residual municipal waste	the fraction of municipal waste remaining after the source separation of municipal waste fractions, such as food and garden waste, packaging, paper and paperboard, metals, glass, [and unsuitable for the production of compost because it is mixed, combined or contaminated with potentially polluting products or materials[148]
sanitation	Process treatment of biowaste, (...) that aims, during the production of compost and digestate that aims to kill organisms pathogenic to crops, animals and man, to a level that the risk of carrying disease in connection with further treatment, trade and use is minimised[149]
stabilisation	the reduction of the decomposition properties of biowaste [to such an extent that offensive odours are minimised and that either the Respiration Activity after four days (AT4) is below 10 mg O2/g dm or the Dynamic Respiration Index is below 1,000 mg O2/kg VS/h[150]
windrow composting	the composting of biowaste placed in elongated heaps which are periodically turned by mechanical means in order to increase the porosity of the heap and the homogeneity of the waste[151]
Worm composting	A composting method that allows biodegradable wastes to be composted using earthworms
VFG-waste (Vegetable-, fruit- en garden waste)	VFG-waste arises by the normal functioning of a private household. It consists of the separated collected organic fraction of household waste including kitchen waste sometimes minus meat and fish residues, and the non-ligneous part of the garden waste. Kitchen waste includes the following compostable materials : potato peels, citrus - or other fruit peeling - vegetable and fruit rests, egg shells, shelling remains, tea bags and tea small pockets, coffee grounds and paper coffee filters, kitchen paper, small quantities of food rests, etc. Garden waste includes from withered flowers and houseplants, tree pruning, hedge trimming, sawdust, mowing, leaves, weeds, rests from vegetable or ornamental garden, etc[152]

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7. Source : Biodegradable municipal waste management in Europe, Part 1 : Strategies and instruments, European Environment Agency, January 2002, p. 10
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9. **Austria**, **Germany**, **Danemark** and **the Netherlands** are pioneer countries in the implementation of the Landfill Directive, having already achieved the target fixed for 2016.
10. Art. 6, a)
11. It states that these wastes do not *dissolve, (…) nor biodegrade (…). The total leachability and pollutant content of the waste and the ecotoxicity of the leachate must be insignificant and in particular not endanger the quality of surface water and/or ground water (art. 2, e))*
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20. For further information about the European Climate Change Programme, see http://europa.eu.int/comm/environment/climat/home_en.htm
21. White paper (COM/97/0599 final) **: Energy for the future: Renewable sources of energy - White Paper for a Community strategy and action plan.** Directive 2001/77/EC of the European Parliament and European Council of 27 September 2001 on the promotion of electricity produced from renewable sources on the internal electricity market.
22. Directive 2000/76/EC of the European Parliament and the European Council of 4 December 2000 on the incineration of waste; OJEC L332/91 of 28 December 2000.
23. *Environment in the European Union at the turn of the century*, Environmental assessment report N°2, European Environment Agency, 1999.
24. Sources : Barth 2000, in *Economic Analysis of options for managing biodegradable municipal waste*, Final report to the European Commission, Eunomia Research and Consulting et al., 2002.
25. Municipal Waste Minimisation and Recycling in European Cities, ACR+ 2000
26. They represent with the 24% of paper cardboard, a potential of more than 50% of biodegradable waste which can be composted or biomethanised.
27. Handbook for the management of biowaste, manual for Slovak municipalities and LRAs, Twinning Light project, PHARE Twinning light project, F. Amlinger (Kompost Entwicklung und Beratung, Austria), E. Favoino and M. Ricci (Scuola Agraria del Parco di Monza), D. Hogg (Eunomia Consulting), 2005
28. "*Drivers for separate collection in the EU, optimisation and cost assessment of high capture schemes*", E. Favoino, VI European Forum on Ressources and Waste Management, Valencia, Spain 6-7 June 2002.
29. Ibid
30. Ibid
31. Economic Analysis of options for managing biodegradable municipal waste, Final report to the European Commission, Eunomia Research and Consulting, p. 39, referring to the Aylesford recycled newsprint Ecobilan (1998).
32. Commission decisions n° 2000/532/EC and n° 2001/118/EC
33. For example, the habit of preparing and eating lunch at home or opting for a quick break at the work place (Scuola Agraria del Parco di Monza, 2004)
34. "Drivers for separate collection in the EU, optimisation and cost assessment of high capture schemes", E. Favoino, VI European Forum on Resources and Waste Management, Valence, Spain, 6-7 June 2002.
35. Ibid.
36. Directive 2004/12/EC of the European Parliament and of the Council of 11 February 2004 amending Directive 94/62/EC on packaging and packaging waste

37. Inzamelen en verwerken van bioplastics met gft-afval wordt mogelijk, 12/04/2005, http://www.senternovem.nl/uitvoeringafvalbeheer/Afvalscheiding/Feiten_over_afval/Gft-afval/Wat_is_gft_afval/afbreekbaar_plastic_in_de_gft_bak.asp
38. Merelbeke bestuur: Afval, Minder kan best http://www.merelbeke/be/bestuur/bes3101.htm
39. Idem
40. Knowaste: http://www.knowaste.com/largescalefacility.htm
41. Composting of Mechanically Segregated Fractions of Municipal Solid Waste – A Review, P. Bardos, r3 Environmental Technology Ltd.
42. Biological treatment of biowaste – 2nd draft, European Commission Directorate General Environment, 12 February 2001.
43. Ibid.
44. Sewage sludge is treated separately.
45. It seems that biogas was already used in Assyria during the 10th Century BC for heating baths. The first anaerobic digestion plant was built in Bombay in 1859. Asian developing countries embraced the technology mainly through community schemes, using the energy to bring electricity to villages, while Europe disregarded the technique excepted for sewage sludge digestion. By 1895, biogas was recovered from a sewage treatment facility and used to fuel street lamps in Exeter, England. Sources : Monnet, F., An introduction to Anaerobic Digestion of Organic Waste, Final Report, Remade Scotland, November 2003
46. 10 days, as opposed to 20 days in the mesophilic process.
47. Animal By-Product Regulation – EC Regulation n°1774/2002 of the European Parliament and of the Council of 3rd October 2002 – see hereafter 4.2.2.1.3.
48. A hydropulper is a wet process using hydraulic forces to break down organics, and to wash and separate non-organics. The light fraction (plastics, wood, textiles, etc.) floats and can be removed from the process by a rake while the heavy fraction settles down and is removed through an airlock mechanism at the bottom of the hydropulper.
49. Composting would ensure a complete breakdown of the organic matter while fixing nitrogen into the humus-like fraction. At the same time, it enriches the compost in phosphorus and micro-nutrients like magnesium and iron.
50. DG ENV.A.2/LM/biowaste/2nd draft, Brussels, 12 February 2001. Op cit. pg. 16.
51. Measure of the speed of consumption of oxygen by the biomass.
52. DG ENV.A.2/LM/biowaste/2nd draft, Bruxelles, 12 février 2001 Op. cit. p. 16
53. European Composting Network - http://www.compostnetwork.info/biowaste/biowaste.htm
54. DG ENV.A.2/LM/biowaste/2nd draft; Brussels, 12 February 2001. Op cit. p. 16
55. Source : http://www.compost.it
56. See above 3.2.1.
57. Source : SOLAGRO, 75 voie du TOEC, 31076 TOULOUSE CEDEX, Tel : +33 (0)5 67 69 69 69, , www.solagro.org, in « *Valorisation des déchets organiques : comment mettre en place vos débouchés ?* », Guide pratique à l’attention des élus locaux, AMORCE
58. Source : Favoino - Calculation: collection of organic waste: 100 kg/inh.year / process yield: 40 % / dry matter 50% / application rate: 10 tonnes/ha d.m.
59. Comparison of Compost standards within the EU, North America and Australia, D. Hogg and al., WRAP, June 2002.
60. http://www.compostnetwork.info/biowaste/index.htm
61. Annex 1 of the Biowaste Ordinance contains a list of biowastes generally suitable for use on land and suitable for composting or anaerobic digestion:
    - **Organic municipal waste** – kitchen and garden wastes, used paper, hair, feathers, excrement of pets (though no manure from farm animals);
    - **Residues from the food and animal feed industry –** residues from the processing of coffee, tea, tobacco, cocoa, gelatine, potatoes, corn, rice, sludge from distilleries, breweries and the production of starch, edible fats and oils, bristle and horn wastes, contents of stomach and intestines, foodstuffs stored for too long, waste from markets, kitchen waste from canteens and restaurants;
    - **Organic industrial waste** – mud and top soil, sawdust, bark, leather, etc.
    - **Mineral composting additives** – lime, bentonite, stone dust, clay.
    - Each type of waste listed in the ordinance has a designated waste code in accordance with the European Waste Catalogue.
62. *Comparison of compost standards within the EU, North America and Australia*, Main report, D. Hogg et al., WRAP, UK, June 2002 p. 36.
63. Comparison of Compost standards within the EU, North America and Australia, D. Hogg and al., WRAP, June 2002.
64. Note that the meaning of ‘mixed’ in this context does not imply ‘unsorted waste’, but to the various categories of source-separated materials included in the starting mix.
65. Animal By-Products Regulation (EC 1774/2002) established sanitary rules applicable to animal by-products for non-human consumption.
66. See notably Annex VI, Chap. II, C., of EC Regulation n°1774/2002
67. Comparison of Compost standards within the EU, North America and Australia, Main report, D. Hogg and al., WRAP, UK, June 2002
68. Comparison of compost standards within the EU, North America and Australia, D. Hogg and others, WRAP, UK, June 2002
69. Only Austria makes end-use specifications part of the statutory framework.
70. A requirement of 94% of respondents to a survey in the South of Germany.
71. The monitoring of the production process and of the product takes two years. During the first year, the producer learns about composting techniques and compost production together with VLACO vzw experts. At the end of this period, the product must fulfil the legal basis standards. During the second year, the monitoring activities shift to the higher product quality (there is a requirement for a superior organic matter content) and process control. The Flemish system requires 8 or 12 tests per year, depending on whether the treatment capacity is lower or higher than 20,000 tonnes per year.
72. Art 5 al 1

73. Biodegradable Municipal Waste management in Europe, Part 1 :Strategies and instruments, EEA, January 2002.
74. "*Composting, the trends and drivers in Europe*", E. Favoino, European Waste Management Review, Issue 1 2003
75. First global composting capacity in Europe
76. Second global composting capacity in Europe
77. Handbook for the management of biowaste, manual for Slovak municipalities and LRAs, Twinning Light project, PHARE Twinning light project, F. Amlinger (Kompost Entwicklung und Beratung, Austria), E. Favoino and M. Ricci (Scuola Agraria del Parco di Monza), D. Hogg (Eunomia Consulting), 2005
78. Les communes rurales ont le choix de ne collecter que les déchets de jardin, et de promouvoir le compostage à domicile.
79. Afval Overleg Orgaan = Dutch waste management council including municipality representatives http://www.aoo.nl
80. http://www.vrom.nl/pagina.html?id=9167 Afscheid van de verplichte afvalscheiding? Een onderzoek naar de communiceerbaarheid van de mogelijke beleidswijziging GFT-inzameling, Dieter Verhue, Julie Visser en Jolanda Fransen, Augustus 2004
81. Pilots in the NL show amounts of GFT being 160 gr/person /day. on average (about 60 kg per person per year).
82. De gemiddelde Vlaming and zijn keuken- en tuin- afval, OVAM, 2002
83. Current Practice in the Collection of Organic Wastes, Final Report to Devon County Council, Eunomia Research and Consulting, 2003
84. Favoino, E; *Drivers, trends, strategies and experiences for proper management of biowaste in the EU*, "International Conference on the Repercussion of UE Policy in Organic Waste Management and its Consequences for the Southern European Countries", ISR-CER, Barcelona, 25 November 2003.
85. Source: Waste sorting analysis at the Treviso 3 district; Stefano Benazzato, Lorenzo Lazzari, Luca Mariotto – Idecom GmbH www.idecom.it, off. papers of Ricicla (2002, Rimini, I)
86. Bins with 2 compartments, one for biowaste and one for residual household waste – Paper, paper board and packaging waste are collected separately door-to-door or by means of recycling parks.
87. See 2.3.3.1. This standard requires 90% biological degradation (to be tested through $C0_2$ evolution in the scope of a standard test) in 6 months.
88. E. Favoino, *Drivers, trends, strategies and experiences for proper management of biowaste in the EU*, op.cit.
89. The Italian Law of 5/2/98 allows composting of max 1000 t/y of garden waste only at civic amenity sites.
90. Home composting has not only an influence on the total residual waste stream but also on the quantity of garden waste brought to Civic amenity sites and on the number of journeys.
91. Biological treatment of biowaste – 2^{nd} draft, European Commission Directorate General Environment, 12 February 2001.
92. Economic analysis of options for managing biodegradable municipal waste, Final Report to the European Commission, Eunomia Research and consulting & al., 2002, pp. 46-47.
93. Economic analysis of options for managing biodegradable municipal waste, op. cit., p. 50
94. Source : Warmer Bulletin, Nov. 2002
95. Source : personal contact, Marco Ricci, Scuola Agraria del Parco di Monza (Italy)
96. Source : personal contact, VLACO vzw
97. Physico-chemical analyses conducted in Belgium by VLACO vzw in 2002 and IDELUX in 2003.
98. Evaluation des politiques de prévention en matière de gestion des déchets ménagers et assimilés, Evaluation des politiques de compostage à domicile, Rapport final pour la DGRNE, Research Development and Consulting (RDC), 2004, p. 16.
99. PHARE Twinning light project, F. Amlinger (Kompost Entwicklung und Beratung, Austria), E. Favoino and M. Ricci (Scuola Agraria del Parco di Monza), D. Hogg (Eunomia Consulting)
100. Article by P. De Bruyne http://www.vlaco.be/home.php?actiefmenu=content&welkemap=preventie&meerinfo=5&paginatitel=Preventie
101. See above 6.1.1. the example of Milton Keynes (UK)
102. http://www.rumst.be/milieu-kippen.htm
103. http://www.vlaco.be
104. A type of composting of biodegradable waste using earthworms.
105. Working document "Biological Treatment of Biowaste", DG ENV.A.2/LM/biowaste/2_{nd} draft, Brussels, 12 February 2001
106. Hazard Analysis and Critical Control Point
107. Costs for Municipal Waste Management in the EU, Final Report to Directorate General Environment - European Commission, D. Hogg and others, 2002
108. On a weekly basis in duobins.
109. Costs for Municipal Waste Management in the EU, Final Report to Directorate General Environment, European Commission, D. Hogg and al., Eunomia Research and Consulting 2002
110. Pre-tax costs plus tax in Flanders
111. Gate fees
112. Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste

113. Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste
114. Prof. Dr.-Ing. Renatus Widmann, Anaerobic Digestion, Techniques and Efficiency, International Conference: Waste Management in the Focus of Controversial Interests Vienna, April 4 – 6, 2005
115. Idem
116. Evaluation des politiques de prévention en matière de gestion des déchets ménagers et assimilés, Evaluation des politiques de compostage à domicile, Rapport final pour la DRNE, Research Development and Consulting (RDC), 2004
117. Source : Carlsbæk, M. SOLUM, personal communication, in Amlinger, F. (2000) 'Composting in Europe: where do we go?' Paper for the International Forum on Recycling, Madrid, 14 November 2000, In Comparison of Compost standards within the EU, North America and Australia, D. Hogg and al., WRAP, June 2002, p. 60
118. Hotels, Restaurants, Catering
119. See presentation here above 6.1.3.1.2.
120. The largest plant produces 4,000 MwH electricity and 40 TJ heat each year.
121. http://www.sft.no/nyheter/dbafile10665.html Ends Daily 05/01/04
122. See hereabove 5.2.
123. For more information : DEFRA website http://www.defra.gov.uk/environment/waste/localauth/lats/index.htm
124. 281 local authorities use the bags, 28 prefer bins. Some authorities distribute a certain amount of bags or stickers for free to households as a means of discouraging undesirable behaviour or as « socially corrective » measures. There is a charge for extra bags, which are set at a slightly higher cost.
125. Some Italian regions have already issued provisions for subsidising farmers using compost in depleted soils. See 1.3.1.
126. The coalition is made up of ASSURRE, the European Compost Network/ORBIC, EEB, FEAD, ISWA, RREUSE. See the letter from this coalition of 6 April 2005 to the European Commissioner, Stavros Dimas, and his response: http://www.biowaste.at/archive_html/sla_050731_corr-coal-dimas.html
127. Commission communication to the European Council, to the European Parliament, to the Economic and Social Committee, and to the Committee of the Regions, *Towards a thematic strategy for the protection of soils* COM(2002) 179 final http://europa.eu.int/comm/environment/soil/
128. Working document "Biological treatment of biowaste", DG ENV.A.2/LM/biowaste/2nd draft, Brussels, 12th February 2001
129. Working document "Biological treatment of biowaste", op. cit.
130. Directive 1999/31/EC of 26 April 1999 on the landfill of waste, Art. 2, m), O.J. n° L182 of 16 July 1999
131. Economic Analysis of options for managing biodegradable municipal waste, Final report to the European Commission, Eunomia Research and Consulting, p. 39, referring to the Aylesford recycled newsprint Ecobilan (1998).
132. Regulation (EC) No 1774/2002 of the European Parliament and of the Council of 3 October2002 laying down health rules concerning animal by-products not intended for human consumption
133. Working document "Biological treatment of biowaste", op. cit.
134. Working document "Biological treatment of biowaste", op. cit.
135. Working document "Biological treatment of biowaste", op. cit.
136. Working document "Biological treatment of biowaste", op. cit.
137. Handbook for the management of biowaste, manual for Slovak municipalities and LRAs, PHARE Twinning Light project, 2004 (op. cit.)
138. OVAM, Uitvoeringsplan Huishoudelijke Afvalstoffen 2003-2007
139. Working document "Biological treatment of biowaste", op. cit.
140. Source : Questionnaire ACRR Waste minimisation in Cities (1998)
141. Working document "Biological treatment of biowaste", op. cit.
142. Working document "Biological treatment of biowaste", op. cit.
143. Directive 1999/31/EC of 26 April 1999 on the landfill of waste, Art. 2 b), O.J. n°L182 of 16 July 1999
144. UNSD/UNEP Questionnaire 2004 on Environment Statistics - Waste Section
145. Source : http://unstats.un.org/unsd/environmentgl/gesform.asp?getitem=775
146. Guide du recyclage des emballages ménagers, AVR-ACR, 1997, p. 27.
147. Working document "Biological treatment of biowaste", op. cit.
148. Working document "Biological treatment of biowaste", op. cit.
149. Working document "Biological treatment of biowaste", op. cit.
150. Working document "Biological treatment of biowaste", op. cit.
151. Working document "Biological treatment of biowaste", op. cit.
152. Source : OVAM, Uitvoeringsplan Huishoudelijke Afvalstoffen 2003-2007