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Composting municipal waste in the UK: some lessons from Europe

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Abstract

Composting is an important element in sustainable waste management for the UK and could potentially have a vital role to play in meeting the obligations of the Landfill Directive. This paper evaluates the current state of the composting industry in the UK using the survey data from 1999 and compares its performance and profile with other countries in Europe. The UK industry profile shows that most waste (92%) is managed by relatively small, centralised sites which typically employ unsophisticated technology. These centralised sites also tend to compost green (garden) waste almost exclusively and this material is usually obtained from collection at civic amenity sites. In relation to the longer-term requirements of the Landfill Directive, it would appear that continued reliance on composting green waste would not be sufficient to meet the targets. Major structural changes will be needed if the industry is to meet the challenges ahead and kerbside collection and composting of both kitchen and green waste will probably have an important role to play. The results from the 1999 survey of composting also suggest that there is a renewed interest in using mechanical and biological treatment to process municipal solid waste directly. After several years of sustained growth, it is clear that the UK composting industry is at a crucial stage in its development. It is the opinion of the authors that the experience of the more advanced composting countries in Europe should be used as a model for the continued development of the UK industry in order to deliver sustainable waste management in the longer term. © 2001 Elsevier Science B.V. All rights reserved.

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1. Introduction

The European Landfill Directive (EC, 1999) will have a profound effect on how the UK collects and processes biodegradable waste. Composting will clearly have an important role in processing much of the biodegradable waste, which in future will have to be diverted from landfill. This paper will focus largely on the kitchen and garden fraction of biodegradable waste, for which composting is likely to be the most appropriate processing option.

This paper will also examine the composting industry in some detail, particularly the large-scale centralised sector processing municipal waste. It will also look at the profile of the UK industry in relation to the more advanced composting countries in Europe in order to find lessons for the future development of the UK sector. Survey data will be used to highlight key features of the sector and these will be used to evaluate the industry's current performance and its ability to meet the challenges ahead. Survey data for 1999 were obtained from a national postal survey of the composting industry and all local authorities in the UK, carried out by the Open University on behalf of the Composting Association. The survey was the largest and most comprehensive survey of the composting industry undertaken so far in the UK. Questionnaires were sent to 685 key stakeholders and there was a 57% response rate. A more detailed report on the results of the 1999 survey can be found on the Composting Association web site (<http://www.compost.org.uk>) (Slater et al., 2001). Although reliable and comprehensive national surveys only began in 1997, other informal but limited surveys carried out by the Composting Association have been used to provide background details for previous years.

2. History of composting in Europe

The concept of large-scale municipal composting appears to have originated in Holland in 1929 with the setting up of N. V. Vuilafvoer Maatschappij (VAM) by the Dutch Government (Gray and Biddlestone, 1980). The facility was used to dispose of the refuse from several cities and to produce compost for which there was a great demand for in land reclamation projects. However, the first serious attempts to use large-scale composting to treat unsorted municipal solid waste (MSW) in Europe began in the 1970s and extended into the 1980s, at which time it was hoped that these types of plants could treat approximately 35% of the total MSW (de Bertoldi, 1999). These plants would typically attempt to process the entire MSW stream and facilities such as these are now known as mechanical and biological treatment plants (MBT). The key element of the MBT process would involve mechanically separating the organic matter fraction from the MSW prior to composting. The plants would also undertake limited recycling of some materials from the MSW such as ferrous metals and plastics and some would produce a refuse derived fuel (RDF) from the remaining light fraction.

However, the quality of the recycled materials, including compost, from these old type plants was often very poor. Because these plants tended to use hammer mills,

shredders or Dano drums to initially reduce the particle size of the incoming MSW, the resulting composted fraction was often heavily contaminated by inorganic debris such as glass and plastics which were found to be impossible to completely screen out. Equally problematic in the compost was the presence of high concentrations of heavy metals (potentially toxic elements), such as mercury and lead, arising from household products. The contaminated nature of the composted materials meant that the composts became increasingly difficult to sell to the public or to use in agriculture (Gruneklee, 1997).

Because of these difficulties and growing environmental awareness, the number of MSW processing plants began to decline in Europe during the 1980s. For example, Gruneklee (1997) reported that there were 18 MSW plants operating in Germany up until 1983 with a total plant capacity of around 0.5 million tonnes per year. However, by 1985, most of these old plants had closed down and a new type of composting plant began to emerge. This new approach to composting in Europe involved separating and processing much ‘cleaner’ biodegradable wastes than mixed MSW in order to produce more acceptable and more marketable products. However, in some southern European countries, where there is a huge need to replenish soil organic matter, MSW composting is still a dominant force. Italy, although now developing extensive source segregation schemes, processed and composted 9.4% of total municipal waste in 1997 using MBT (Favoino et al., 1999).

The composting industry in the UK has tended to reflect the history and changes taking place in Germany and other northern European countries. Gray and Biddlestone (1980) reported that a study of unsegregated MSW composting plants in 1971 had shown that there were 13 operating plants. A subsequent survey in 1977 identified only 10 operational plants and noted that only one new plant had been commissioned since 1971 while a number had closed down. None of the MSW composting plants identified in the 1977 survey are currently in operation. Although a number of centralised plants for sorting and recycling unsegregated MSW have been subsequently built in the UK, none are currently producing marketable composts. This point is discussed further in later sections.

3. Development of the modern composting industry Europe

Increasing legislation and higher environmental standards appear to have been responsible for encouraging the development of a new generation of composting facilities throughout Europe. A cornerstone of the new approach to composting has been the realisation that only good quality compost derived from uncontaminated wastes has the potential to be sold to the public, used in agriculture or in large-scale reclamation projects (Gruneklee, 1997; Schenkel, 1997). Hence, Barth and Kroeger (1998) have noted that “European policy exhibits a trend towards rapid development of source segregated organic waste composting”.

It is estimated that around 60 million tonnes of potentially recoverable organic waste is produced in the EU each year. Of this 60 million tonnes; France produces 24%; Germany, Italy and the UK 15% each; Spain 11%; Austria 4%; Belgium,

Greece and the Netherlands 3% each; Sweden and Portugal 2% each, and Denmark, Finland and Ireland each contribute 1% (DHV, 1997). Approximately 15% (9 million tonnes) of the recoverable organic fraction is currently recovered through home composting or source separation and centralised composting throughout the EU. However, this European average masks large differences in the amount of organic waste currently recovered for individual Member States (see Table 1).

From Table 1, it can be seen that the UK in 1997 recovered relatively little of its municipal organic waste (6%) compared with some other European countries, and current research presented here suggests that little has changed. In contrast, the five countries with source segregation policies and infrastructure in place, Austria, Belgium, Denmark, Germany and the Netherlands, collect and compost around 85% of all the organic waste collected and composted in the EU. The organic material collected from source segregation schemes tends to comprise mainly the vegetable, fruit and garden (VFG) waste fraction. Although the trend is towards increasing levels of source segregation, those countries with poorly developed source segregation schemes tend to compost unsegregated MSW, producing large quantities of low quality compost (de Bertoldi, 1999).

In 1996, between 50–60% of German households were serviced with a collection scheme for source segregated organics, with a target to reach 90% (DHV, 1997). In the Netherlands, organic source segregation is virtually nation-wide, with 94% of all

Table 1

Separately collected and composted household organic waste (including home composted) plus amounts of compost produced in various EU Member States (Frick et al., 1999)

EU member state	Household organic waste		Compost produced
	Quantity of organic waste recovered ('000 tonnes)	Total recoverable in each country (%)	Quantity ('000 tonnes)
The Netherlands	1800	90	650
Denmark	500	55	250
Austria	1100	50	500
Germany	4000	45	2000
Belgium	320	34	160
Sweden	250	16	100
Luxembourg	7	14	3
Finland	70	10	30
UK	317	6	159
France	400	3	150
Italy	200	2	100
Portugal	0	0	0
Spain	0	0	0
Greece	0	0	0
Ireland	0	0	0
Total	8964	(total 15 recovered)	4102

municipalities separately collecting VFG from more than 95% of households (DHV, 1997). In Finland, source segregation is progressing rapidly in response to organic waste recycling targets (Barth and Kroege, 1998).

Processes employed to compost source segregated household waste vary considerably throughout Europe. The simplest of these and by far the most common are outdoor windrow systems. These typically comprise long rows of waste (windrows) which are mechanically turned by a vehicle to aerate and mix the waste, thus promoting rapid decomposition. These simple outdoor systems are mainly used to compost garden waste. Enclosed composting operations tend to be more sophisticated and often use computer controlled, fully automated tunnel, channel and box processes. These more technically advanced processes often employ forced aeration systems and environmental protection measures to control odour emissions. They are typically used to process the more putrescible fractions of MSW, such as kitchen waste.

Germany is typical of advanced composting countries in terms of having installed a very diverse range of composting plants from simple windrow systems to more technically advanced processes. Gruneklee (1997) noted that in 1995, around 28% of the composting plants in Germany were technically advanced and these composted around 50% of the 4 million tonnes of source separated household waste collected. Plants composting exclusively garden waste amounted to only 30% of the total number of plants in Germany while the remaining 70% composted either kitchen waste on its own or a mixture of kitchen and garden waste. Source segregation and composting is developing very rapidly in Germany. Compared with the figures given in Table 1, which were collected in the early to mid 1990s, Gruneklee (1997) estimated that at the beginning of 1997, Germany composted 77% of its 8 million tonnes of household organic material which is potentially recoverable. This significant increase in the amount of waste collected and composted was also reflected in a steep increase in the number of composting plants, rising from 378 in 1995 to 520 in 1997.

In anticipation of the European Union Directive on the Landfill of Waste, Germany has had strict regulations in place for some time prohibiting landfilling of waste without prior treatment (Frick et al., 1999). This is to minimise environmental problems caused by landfilling biodegradable waste. Consequently, in addition to composting the separately collected VFG fraction of municipal waste, Germany has also been investigating the use of MBT processes to pre-treat prior to landfill, the organic material still remaining in the waste stream after source segregation. This waste is sometimes referred to as 'restwaste' or 'residual waste'. Results from the German research into using MBT to treat restwaste suggest that MBT should prove to be a viable alternative to incineration for treating these types of wastes prior to landfill (Frick et al., 1999).

The European Union Directive on the Landfill of Waste, which came into force in 1999, embodies many of the ideas and environmental concerns that have stimulated countries such as The Netherlands and Germany to develop successful, sustainable waste management programmes. The Directive is likely to have a profound effect on the way in which biodegradable waste is collected and processed

and will inevitably stimulate the development of the composting sector throughout the EU and especially in the UK.

The overall aims of the Directive can be summarised as follows:

- to harmonise landfill standards amongst Member States;
- to reduce landfill gas emissions;
- to promote the separate collection and recycling/treatment of biodegradable MSWs; and
- to increase the cost of landfill, so that it reflects the full costs, including environmental costs.

Most significantly, the Landfill Directive places strict limits on the amount of biodegradable municipal waste that can be disposed of to landfill, and introduces a requirement for pre-treatment of all waste prior to landfill. A further working document from the European Commission (DG ENV.E.3 of the European Commission, 2000), published in October 2000, aims to complement the Landfill Directive by giving guidance on the biological treatment of biodegradable wastes. For the first time, the document proposes sets of uniform standards for different classes of composts produced from source segregated wastes and also proposes standards for 'stabilised biodegradable waste' derived from MBT of municipal waste. The potential implications of the Landfill Directive and the working document in relation to the development of the UK composting sector are discussed in Section 5.

4. The current state of the UK composting industry

Preliminary findings from the 1999 survey give an outline of the current state of the composting industry. The survey was carried out using a 23-page questionnaire posted to key stakeholders, including all local authorities in the UK, members of the Composting Association, members of the Community Composting Network, and non-member organisations in the water and waste management sector. The questionnaire included sections on current composting operations and future plans, site licensing and planning, collection systems, markets and end-use for the composted material and home composting. The questionnaire was piloted and amended before distribution. Two written reminders were sent to non-respondents, one before and one after the closing date. Where possible reminders were sent using e-mail. Any non-respondents known to be composting were given additional telephone reminders to ensure their response. The original closing date was extended to include late responses. Out of a total 685 questionnaires distributed, 388 completed questionnaires were returned, giving a response rate of 57%, almost three times the response rate of the previous year.

Compared with many other European countries, the UK recovers and composts only a small fraction of its potentially recoverable municipal organic waste. European countries that are currently achieving high levels of organic waste recovery and composting are doing so through the adoption of source segregation legislation or mandatory targets and the widespread use of kerbside collection

Table 2
The throughput of centralised composting sites

Throughput of individual sites (tonnes per year)	Number of sites	Percentage of centralised site throughput (%)
<7000	45	21
7000–<14 000	14	19
14 000–<21 000	11	23
More than 21 000	10	37
	80	100

schemes. Typically these countries collect both garden and kitchen waste. In contrast, the 1999 survey found that the UK relies almost exclusively on composting the garden waste fraction of municipal waste, this being largely derived from civic amenity (CA) sites.

To date, this focus on garden waste, which is also known as green waste, does not appear to have constrained industry growth. The overall picture for composting in the UK is one of continued expansion as reflected in the growth of centralised sites over the last decade, illustrated in Fig. 1. The 1999 survey also revealed that 833 000 tonnes of material in total (municipal and non-municipal) was composted in 1999. Centralised sites composted the most by far (92%) with only 8% being composted at on-farm sites or community run sites. The 1999 throughput showed an increase of around 23% on the previous year, and an even greater increase (around 29%) is predicted for 2000 according to the survey responses.

Of the 80 centralised sites, 45 sites processed less than 7000 tonnes in 1999, with the most common size being 5000–6000 tonnes (Table 2). Of the 65 on-farm sites identified, 90% composted less than 1500 tonnes per site, and of the 52 community sites identified, 98% composted less than 100 tonnes per site. Based on this current performance, centralised sites will have a more dominant future role than other site types in terms of diverting large quantities of organic waste from landfill.

Table 3 shows the source of UK municipal and non-municipal waste composted in 1999. Of the total waste composted, almost 619 000 tonnes, around 74% was municipal waste. As mentioned earlier, UK composting is dominated by garden or green waste. Around 93% of municipal waste composted was green waste. Of all municipal waste collected for composting, 72% of this was green waste from CA sites, 17% was from Local Authority parks and gardens and only 4% was garden waste collected from the kerbside.

Although the proportion of organic waste collected from the kerbside has remained relatively constant since 1997, the survey indicated that this is likely to increase in the future; 42 Local Authorities said they currently operate a scheme, 61 said they are planning to introduce a kerbside collection scheme and 12 said they are considering implementation. The survey also revealed a renewed interest in mixed MSW composting (or MBT) with 10 composting operators planning to open an MBT plant or conduct trials.

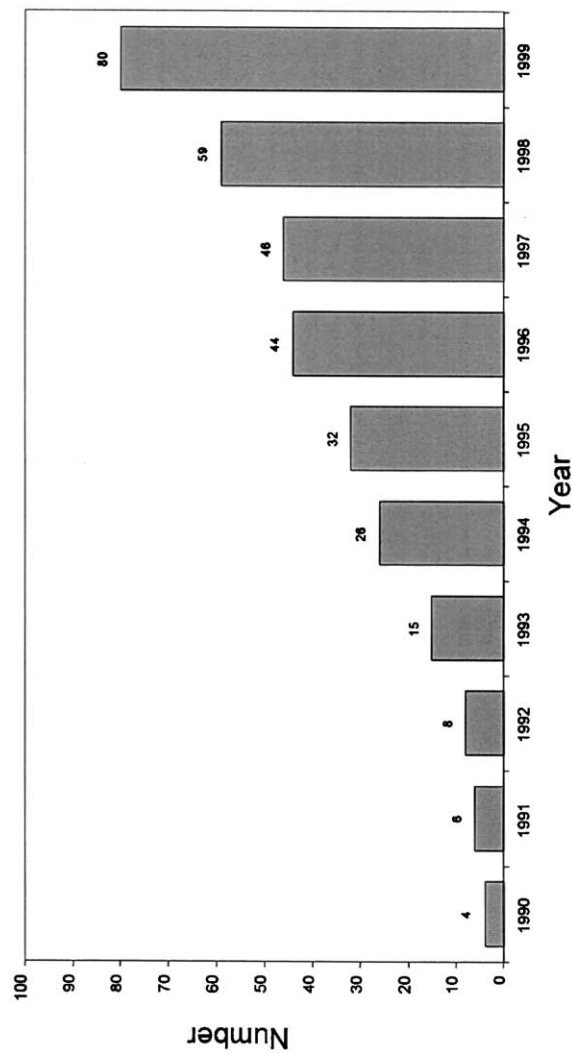


Fig. 1. The increase in the number of centralised composting sites in UK.

Table 3
The source of municipal and non-municipal waste composted in 1999 ^a

Type of waste composted	Quantity of waste composted (tonnes)	Proportion of total waste composted (%)	Proportion of municipal waste composted (%)	Proportion of non-municipal waste composted (%)
<i>Municipal</i>				
Household garden waste from CA sites	447 044	53.7	72.3	na
Garden and kitchen waste collected from kerbside	21 602	2.5	3.5	na
Garden waste collected from kerbside	24 530	2.9	4.0	na
Other household	344	<0.1	<0.1	na
Green waste from local authority parks and gardens	107 762	12.8	17.4	na
Other (non-household)	17 235	2.1	2.8	
Total municipal waste composted in 1999	618 517	74.0	100.0	na
<i>Non-municipal</i>				
Green waste from landscaping	21 438	2.7	na	10.0
Industrial processes	136 303	16.5	na	63.8
Agricultural activities	32 060	3.9	na	15.0
Other non-municipal	23 939	2.9	na	11.2
Total non-municipal waste composted in 1999	213 740	26.0	na	100.0
Type not specified	787	<0.1	na	na
Total composted in 1999	833 044	100.0		100.0

^a na, Not applicable.

Respondents to the survey reported that around 57% of the 460 000 tonnes of composted material produced was sold to the public or trade, mainly as soil conditioners or mulch. A further 29% was used on-site for purposes such as landfill restoration or landfill cover, and only 14% of the material produced was distributed without charge.

5. Impact of the landfill directive

Article 5 of the Directive places strict limits on the amount of biodegradable municipal waste that can be disposed of to landfill in the future. Limiting the amount of biodegradable waste going to landfill implies the diversion of this waste towards appropriate treatment options such as composting. For the UK, the amount of biodegradable municipal solid waste (BMSW) that can be disposed of to landfill must be reduced to:

- 75% of the amount produced in 1995, by 2010;
- 50% of the amount produced in 1995, by 2013; and
- 35% of the amount produced in 1995, by 2020.

It is normally assumed that BMSW refers to the food, garden, paper and paperboard fraction of MSW that is collected by a local authority (or one of its agents). A large proportion of BMSW will be made up of paper and cardboard and within an integrated waste management framework the best practicable environmental option (BPEO) may be recycling or incineration with energy recovery rather than composting. However, a substantial fraction will be the organic fraction comprising garden and kitchen waste, where the BPEO is more likely to be composting. Hence, it has been assumed here that future composting effort in the UK will be devoted to diverting VFG wastes rather than other biodegradable wastes, derived largely from paper and card.

UK Government estimates of the proportions of biodegradable waste (53%) and kitchen and garden waste (20%) normally found in municipal waste are now very dated and widely disputed. In particular they appear to greatly underestimate the large amount of garden waste produced in the UK (Warren Spring Laboratory and Aspinwall Ltd., 1994a,b) and it is likely that the amounts of biodegradable waste as well as organic waste in MSW are currently much greater than Government estimates suggest. Other published figures for the average biodegradable fraction of the MSW stream range from 53 to 59% (Gandy, 1993; Robinson and Stentiford, 1993; Nesaratnam et al., 1997). Equally, the proportion of organic waste has been estimated as 29.1% (Nesaratnam et al., 1997), 25.7% and 29% (Coggins, 1999) and 28% (Robinson and Stentiford, 1993). Another study in the West Midlands of England found the biodegradable fraction to be 61% of MSW while the organic fraction was around 32% (MEL Research, 1994). This report also estimated that garden waste in refuse amounted to around 7.2% of the total with as much again being deposited directly to CA sites. Hence, in practice it is likely that the overall proportions of biodegradable waste and organic waste in MSW in the UK could now be as high as 60 and 30%, respectively. Garden waste could account for as

much as 15% of MSW and these estimates are similar to other European countries (Schenkel, 1997; de Bertoldi, 1999). Table 4 contains estimates for waste to be diverted from landfill and these estimates reflect the uncertainty over the composition of household waste.

6. Discussion

Preliminary analysis of the survey data for 1999 shows the UK composting industry continuing to expand strongly, providing a sustainable alternative to landfill for municipal organic waste. The average rate of growth in the number of centralised composting facilities over the last five years was approximately 25% each year and this growth in sites was also reflected in the increase in throughput. The amount of municipal waste composted in 1999 (619000 tonnes) was 21% greater than in the previous year (512000 tonnes) and the results of the 1999 survey forecasts that the amount is likely to grow by a similar amount (maximum 29%) in the year 2000. The composting sector appears to be an industry showing rapid growth in capacity matched by an ability to find markets and uses for the resulting composted products. This raises the question whether the rapid growth observed in UK composting is sustainable? Is the industry focussing on the most appropriate material and utilising the most suitable processes to meet the very onerous targets laid out in the Landfill Directive, and to deliver an option for sustainable waste management in the longer term?

Table 4

Estimates of the quantities of BMSW and organic waste to be diverted from landfill to meet the Landfill Directive Targets

Year	Total BMSW to be diverted from landfill (million tonnes per annum)	Organic fraction (garden and kitchen waste) to be diverted from landfill (million tonnes per annum)
2010	12.4–15.5	4.9–7.7
2013	18.5–21.9	7.3–10.9
2020	26.8–31.0	10.6–15.5

Assumptions made in calculations for Table 4:

- municipal waste arisings in 1995 in the UK were 29 million tonnes;
- waste arisings increase by 3% per annum from 1995 (DETR, 2000);
- the composition of the biodegradable fraction remains constant and is assumed to be between 53 and 60%;
- the organic fraction (garden and kitchen) ranges from 20 to 30%;
- the Landfill Directive targets will apply equally to each BMSW type; and
- UK opts for the four year derogation period.

6.1. *The industry in detail*

A more detailed analysis of the centralised composting industry, which handles around 92% of all waste composted in the UK, suggests that the industry differs significantly in certain respects from other European countries more advanced in the use of composting. In theory, an estimated 10 million tonnes of municipal organic waste is currently available for composting in the UK. In 1999, around 619 000 tonnes of municipal organic waste was recovered, equating to a 6% recovery rate, and 93% of this was garden waste. In contrast, Germany recorded a 77% recovery rate in 1997, and only around 30% of plants handled exclusively garden waste (Gruneklee, 1997).

Despite rapid growth in the UK composting industry, results of the 1999 survey raise serious concerns about its ability to deliver sustainable waste management in the longer term and pressing structural changes may be necessary. Concerns centre on three main features of the current industry profile: (1) the sector is dominated by small sites, with typical throughputs of around 5000–6000 tonnes per year, and forecasts for 2000 confirm this dependence on small sites is set to continue. At present these small sites comprise more than 50% of all sites but account for only 20% of waste composted. (2) In terms of processing municipal waste, the industry is totally dependent on composting garden wastes (93%), rather than processing kitchen wastes, which are potentially the more environmentally polluting fraction of household waste. Furthermore, much of the garden waste (72% of municipal waste) is collected from CA sites. (3) Because of the continued emphasis on composting relatively benign garden wastes, the industry is based on relatively unsophisticated composting technology and management systems with 90% of sites employing open air windrow systems.

6.2. *Meeting the targets*

The Landfill Directive seeks to reduce the amount of biodegradable municipal waste going to landfill. Of particular relevance to the composting industry is the kitchen and garden waste fraction of municipal waste because that is the fraction where BPEO is most likely to be composting. The first Landfill Directive target in 2010 requires UK to have diverted between 4.9 and 7.7 million tonnes per annum of organic material in MSW from landfill (see Table 4). In 1999, the UK composting industry processed around 619 000 tonnes of municipal waste and the composting capacity was estimated to be growing at around 22% per year. If this growth and current sector profile is maintained, it is possible that around 5 million tonnes of waste could be processed and this would require approximately 600 composting facilities, many of which would be relatively small. An eight-fold expansion of the present composting capacity would be required and this would only reach the lower end of the target. Meeting subsequent targets would require at least a twelve to sixteen fold expansion in the current composting capacity. Can this growth be achieved in practice and can it be sustained in the longer term without major structural changes in the way UK collects and composts waste?

A major factor in determining growth and shaping the form of the industry relates to future waste production, composition and collection. If the emphasis on green waste composting is maintained then around 93% of the waste composted in 2010 would be garden waste. If it is assumed that garden waste comprises 15% of municipal waste and that the amount of waste increases by 3% per year then sufficient green waste could be available for collection and composting in 2010 to meet the first Landfill Directive target, at around 7 million tonnes. However, it is highly likely that only a fraction of this garden waste would actually be available for composting. For example, at present most garden waste (72%) is collected via CA sites, which serve only a relatively small number of the UK population. For England and Wales, in 1997/98, only 480 CA sites existed and these collected on average 80 kg of garden waste per household served per year (DETR, 2000). On the basis of these figures, even if similar CA sites were to be extended to cover the whole of the UK, it is likely that less than two million tonnes of garden waste would be collected every year by this route. Although important to the current profile of the composting industry, garden waste from CA sites, coupled with additional parks and garden waste, is unlikely to be a sufficient source of material to sustain future growth if the industry is to meet the obligations ahead.

In considering how the industry may develop to complement the current small scale garden waste sites, two interesting, and potentially conflicting features emerged from the 1999 survey. The most obvious of these is that source segregation and kerbside collection of household organics are set to rise considerably, with more schemes planned than are currently in operation. Secondly, the survey revealed a renewed interest in MBT to treat unsorted municipal waste. These two possible future routes are now discussed with particular reference to lessons learned in Europe.

As mentioned earlier, source segregation and kerbside collection of organics is requisite in countries advanced in composting. In Italy, it has been estimated that between 30 and 70 kg of garden waste may be collected per person per year using kerbside collections. When garden waste has been combined with the collection of kitchen waste recovery rates can be as high as 150 kg per person per year (Favoino et al., 1999). In UK terms, with approximately 2.5 persons per household, this suggests that kerbside collections could at present recover up to 375 kg of organic waste per household per year. This compares with the current, very limited capacity of collecting only 80 kg of garden waste per household per year from CA sites. Estimates suggest that there will be over 13 million tonnes of kitchen and garden waste available for composting in the UK in 2010. Kerbside collection schemes similar to those already common in other European countries could deliver over 8 million tonnes of household waste for composting. These figures suggest that kerbside collection of both kitchen and garden waste is a realistic method of recovering the large amounts of organic waste that will be required if the UK is to achieve the first and subsequent Landfill Directive targets.

Adopting a model involving kerbside collection of kitchen waste as well as garden waste would also have a profound effect on how the industry composts waste due to the putrescible nature of the kitchen waste fraction, and the associated

potential for increased environmental impact. This would mean a change from largely outdoor systems of composting to more sophisticated enclosed processes. At present there are a number of other factors impinging on the growth of the composting sector which are also shaping its form now and, unless addressed, will continue to do so in the future. Composting operations, especially outdoor facilities, are known to have a high environmental impact resulting from odour and bioaerosol emissions and noise problems (Wheeler and Bourn, 2000). Consequently, licensing and planning issues have often been cited as the main reasons for constraining growth in the composting sector (ENDS, 1997). Is it realistic to assume that suitable sites will be found for hundreds of small outdoor facilities, with the likelihood of many being situated near to highly populated areas, or would it be more practical to consider a number of much larger enclosed facilities with high levels of environmental control, such as those found in Germany? Finding markets for the large amount of compost expected to be produced in the future has always been an issue. However, at present finding outlets for compost appears not to be a major problem and agriculture has been identified as the most likely end user in the longer term (Wheeler et al., 1996).

In addition to source segregation and kerbside collection, the 1999 survey suggested that mixed MSW composting is likely to feature more heavily in the future. 'Mixed MSW composting' is the term usually used in UK to refer to those processes that other European countries term 'mechanical and biological treatment' or 'bio-stabilisation'. This issue of semantics is important, since the 'composting' process implies the production of a 'compost' rather than simple treatment of the waste. The experience from UK and advanced composting countries in Europe suggests that MBT of mixed MSW is unlikely to produce a composted material that would meet the exacting standards required for marketing to the public or for use in agriculture (Grunklee, 1997). The European Commission's working document on the 'Biological Treatment of Biodegradable Waste' (DG ENV.E.3 of the European Commission, 2000) suggests quality standards for, and makes a clear distinction between, a quality compost produced from a composting process, and stabilised biodegradable waste produced from MBT. The assumption in this document is that composts are derived from relatively uncontaminated source segregated wastes while MBT of unsegregated MSW produces stabilised biodegradable waste which, if conforming to strict standards, may be used in land restoration projects.

At present there are many uncertainties surrounding mixed MSW processing/composting in the UK. A clearer 'composting' definition is required, that distinguishes between 'composting' to produce a quality product and 'composting' as a treatment to stabilise the organic fraction in municipal waste. Guidelines and standards in the European Commission's working document should help address some of the current uncertainties surrounding possible uses, including landfill cover, for the processed/composted material.

Despite these uncertainties, mixed MSW composting (or MBT) is likely to have a valuable role to play as a pre-treatment stabilisation method prior to landfill, thereby helping to meet the Landfill Directive pre-treatment and diversion targets.

However, UK policymakers need to provide a framework so that as MBT develops it is able to emerge as a treatment process that integrates with, rather than competes against, source segregation and kerbside collection.

7. Conclusions

Composting is an important element in sustainable waste management for the UK and could potentially have a vital role to play in meeting the obligations of the Landfill Directive. After several years of sustained growth, it is clear that the UK composting industry is at a crucial stage in its development. Continued reliance on small-scale green waste composting is not sufficient in the longer term and it is the opinion of the authors that structural changes will be needed if the industry is to meet the challenges ahead.

The experience of other more advanced composting countries in Europe suggests that a sustainable approach to recovering significant amounts of municipal organic waste depends on establishing extensive source segregation and composting networks. An evaluation of the current profile and the long term needs of the composting industry in the UK confirms that widespread adoption of source segregation is a technically feasible option for the UK. The results from the 1999 survey of composting suggest that many local authorities are actively investigating or commissioning source segregation schemes, and there is also a renewed interest in using MBT to process MSW directly.

In many European countries, these two technologies will increasingly complement each other. In general, organic waste, separately collected, will be composted to produce quality products whilst MBT will be used to stabilise residual or restwaste after source segregation has removed most of the organic fraction. It is not clear to what extent the UK will reflect best practice as demonstrated in the more advanced composting countries, but the lessons from the past suggest that adopting widespread MBT of unsegregated MSW will not be sustainable in the longer term.

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