

Biodegradable municipal waste management in Europe

Part 1: Strategies and instruments

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Foreword

The ambitious objective of this report is to assist decision-makers in Europe in their efforts to comply with the demanding targets set out in the EU Landfill Directive by providing background information on applicable strategies and instruments to reduce the quantities of biodegradable municipal waste. It is hoped that the information provided by this report will inspire the responsible authorities to benefit from each other's experience and set up more quickly the national strategies needed for implementation of this Directive.

In this report, the concept of waste minimisation/prevention, a key issue for the EU sustainable development strategy, is followed for such a "difficult" waste stream as biodegradable municipal waste. For many decades it was thought that this kind of waste stream has to be finally disposed in landfill sites, since prevention/recycling schemes cannot be easily applied due to its characteristics (rapid decomposition, release of odours etc.). This perception has led, as stated in our *Environmental Signals 2001* report, to the production and landfill of millions of tonnes of biodegradable municipal waste, which demand large land areas for their disposal and adversely affect environmental quality (greenhouse gas emissions, groundwater pollution etc).

This report is an example of the combination of existing statistical information (data on waste quantities landfilled) with the assessment of more qualitative aspects such as the strategies applicable in countries. This inter-linkage brings to the user a more integrated picture of the magnitude of the problem and the results achieved after the implementation of reduction measures. As a matter of fact, the statistics directly underpinned the development of national strategies and the design of relevant instruments for waste reduction.

We sincerely hope that this example of **best needed information** will increase the added value of EEA products as a substantial input in the decision-making process in Europe and inspire the widespread adoption of creative ideas in the field of waste minimisation and prevention.

Domingo Jiménez-Beltrán

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Executive summary

Introduction

Council Directive 1999/31/EC on the landfill of waste (the landfill directive) places targets on Member States to reduce the quantities of biodegradable municipal waste (BMW) going to landfill. To meet these targets, Member States are obliged to set up national strategies for the implementation of the reduction of biodegradable waste going to landfill.

The principal objective of this report, prepared by the European Topic Centre on Waste (ETC/W) as part of the EEA work programme, is to provide Community-wide information on the current status of biodegradable municipal waste management and the various options available to reduce amounts going to landfill. The report addresses the strategic planning requirements to meet the targets and should be seen as a general guidance tool for EU Member States to assist them with the challenge ahead. It also sets out a methodology and indicators for measuring progress towards the targets set out in the directive and focuses on the attainment of these targets.

Approach

Summary information on biodegradable municipal waste production and management was sought from EEA member countries. This information was used to prepare **BMW Management status sheets** for each country. Information was also sought from each country on the strategies and instruments that are used to encourage the diversion of biodegradable municipal waste away from landfill. Strategies and instruments are presented and discussed for each phase in the production and management of BMW. Case studies are also presented for selected countries and regions (Denmark, the Netherlands and Belgium/Flanders) that have succeeded in diverting more than 80 % of BMW produced away from landfill so that lessons can be learnt from their experience.

Technology and market issues were also addressed with the emphasis being on technologies that are available for diverting biodegradable municipal waste away from landfill and on quality and market issues in relation to products or materials produced through the recovery of biodegradable municipal waste diverted from landfill (a companion report on technology and market issues can be downloaded from www.eea.eu.int).

Key issues

The key issues that ETC/W considers to be of particular importance when planning for compliance with the targets set by the landfill directive include:

The need for good quality and consistent information

A standard approach to tracking progress towards the landfill directive targets is needed. A standard approach to tracking BMW flows in individual countries would also be a useful tool for measuring progress towards the achievement of the targets. However, based on the information supplied by EEA member countries during the course of this project, there are considerable gaps in information at national level. It is therefore important that efforts be continued to establish harmonised systems of data collection and reporting so that reliable waste flow information becomes the norm and not the exception. Ongoing collaboration between ETC/W, Eurostat and the Environment DG will assist this process.

There is also a need for more detailed descriptions of the actual waste types to be considered under the heading 'biodegradable municipal waste' as well as guidelines on how to establish the composition of the bagged (mixed) waste component.

Integrated approach to developing national strategies

The experience of countries and regions that have succeeded in diverting large quantities of BMW away from landfill strongly suggests that an integrated package of options is needed at national level to achieve high diversion rates. Countries with high rates of diversion of BMW away from landfill employ a combination of separate collection, thermal treatment, centralised composting and material recycling. Thermal treatment, mainly incineration, is generally used for the treatment of bagged waste while composting, re-use and recycling are used for separately collected wastes such as paper and cardboard, textiles, wood, garden wastes and, to a lesser extent, food wastes. Technologies such as anaerobic digestion, gasification and pyrolysis are in use to a lesser extent, although as the technologies develop their use could become more widespread.

Countries should therefore identify a range of options for managing BMW that is diverted away from landfill which would need to be linked clearly to available markets and outlets for materials diverted away from landfill.

Collection systems

All countries and regions surveyed employ traditional 'bagged waste' collection and separate collection. Generally, traditional 'bagged waste' is either landfilled or incinerated, although some non-thermal treatment also occurs, such as central composting for mass reduction only. The key to achieving both high landfill diversion rates and high re-use, recycling and composting rates (i.e. recovery other than energy recovery) appears to be the provision of widespread separate collection facilities, together with the availability of adequate capacity and markets for the materials thus collected.

Source separation and separate collection should therefore be considered for inclusion in national strategies for meeting the targets set by the landfill directive. This suggestion comes with a note of caution. Each country will need to work out a realistic and achievable target for source separation and separate collection so that it is reasonably confident that the quality of the recovered materials are sufficiently high and that viable markets and outlets exist.

Treatment options

At present, there appears to be a relatively small number of proven treatment options available for BMW diverted away from landfill. The three principal alternatives in use are incineration with energy recovery (mainly of bagged waste), central composting (mainly of garden wastes and, to a lesser extent, food wastes), and material recycling (mainly for paper and cardboard wastes). Some other routes are in use such as anaerobic digestion and use of food waste as animal fodder, but generally, for relatively small quantities of waste. More recent or emerging technologies such as gasification and thermolysis may also play a role in national strategies for the management of BMW. In developing a national strategy to reduce the quantities of biodegradable waste going to landfill, individual member countries should therefore consider the suitability of these options both at national level and at local level. The precise mix of treatment options chosen by a particular country or region will, to a large extent, be based on local or national conditions such as public acceptance of specific technologies.

Availability of markets and other outlets for compost and other end products

When countries are drawing up their national strategies, it is vital that the question of markets and other outlets be addressed. While it is possible to put the infrastructure in place for separate collection and treatment of materials such as paper waste, garden waste and food waste, there is no guarantee that reliable and stable markets will be available for the materials produced. National planners should be fully aware of the importance of establishing and maintaining adequate markets and outlets when drawing up national strategies and plans for the diversion of BMW away from landfill.

Bans and restrictions on landfilling/use of disposal taxes

A key instrument available to individual countries is to impose bans or restrictions on the landfilling of specific waste streams or to tax disposal in order to make recovery a more economically viable option. Several countries have already introduced such restrictions and taxes and the particular design of these instruments very much depends on local and national

social, economic and political conditions. Some countries and regions have adopted or are considering outright bans on the landfilling of either the entire biodegradable fraction of the municipal waste stream while others have introduced a taxation system which increases the cost of landfilling so as to make recovery options more economically viable. Perhaps the optimum approach is to have a combination of progressive restrictions on acceptance of specific waste streams at landfills together with a taxation system that increases the cost of landfilling to a point where it is no longer a financially attractive option. However, whatever approach a country chooses to take, it is essential that alternative routes be identified in advance for waste diverted away from landfill.

Monitoring national strategies for BMW

The landfill directive sets out clear targets and a clear timeframe for reducing the absolute quantity of BMW being consigned to landfill. By basing the target on 1995 production data, a clear roadmap is available for each country, provided that reliable data, or at least agreed data, is available for BMW production in 1995, in accordance with the requirements of the directive. The net impact of future growth in BMW production is that larger quantities of BMW will require treatment by routes other than landfill. It is therefore essential that, as part of its national strategy, each country set up a monitoring and management system that will allow it to track BMW production and management on a continuous basis. Such a system would make the link between production and management of BMW, its subsequent management and the final destination or use of materials, such as compost, produced through its management. Monitoring should be conducted on a continuous basis so that instruments and strategies in use to divert BMW away from landfill are regularly audited and checked for their relative effectiveness and remedial action taken where necessary.

1. Introduction

1.1. Background

Council Directive 1999/31/EC on the landfill of waste (the landfill directive) places targets on Member States to reduce the quantities of biodegradable municipal waste (BMW) going to landfill. To meet these targets, Member States are obliged to set up national strategies for the implementation of the reduction of biodegradable waste going to landfill.

The principal objective of this report, prepared by the European Topic Centre on Waste (ETC/W) as part of the EEA work programme, is to provide Europe-wide information on the current status of biodegradable municipal waste management and the various options available to reduce amounts going to landfill. The report addresses the strategic planning requirements to meet the targets and should be seen as a general guidance tool for EU Member States to assist them with the challenge ahead. It also sets out a methodology and indicators for measuring progress towards the targets set out in the Directive and focuses on the attainment of these targets.

1.2. Terms of reference

The terms of reference for this report are as follows:

- to establish information on existing biodegradable municipal waste management practices in Europe;
- to document the strategic approaches to biodegradable municipal waste management in Europe;
- to provide information on technologies available for diverting biodegradable municipal waste away from landfill;
- to investigate quality and market issues in relation to products;
- to identify key issues and indicators in relation to meeting the targets set by the landfill directive.

1.3. Context

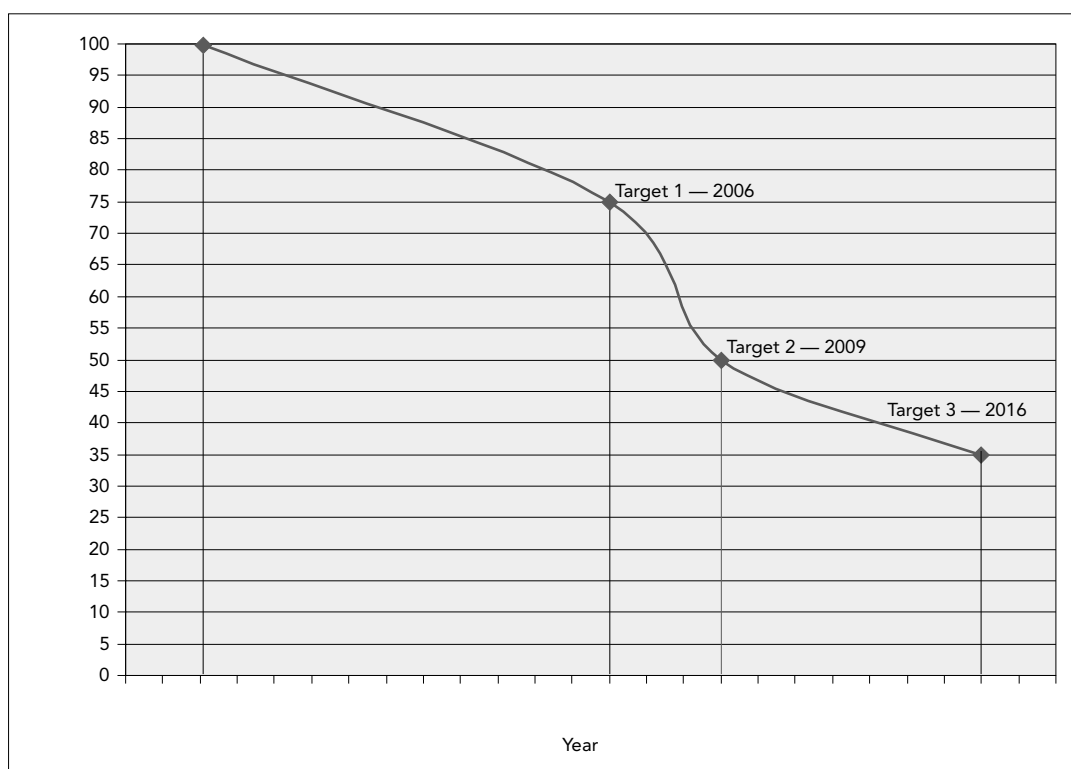
The targets set by the landfill directive are set out in Article 5 of the directive and require the following:

- not later than **16 July 2006**, biodegradable municipal waste going to landfill must be reduced to **75 %** of the total amount by weight of biodegradable municipal waste produced in 1995 or the latest year before **1995** for which standardised Eurostat data is available;
- not later than **16 July 2009**, biodegradable municipal waste going to landfill must be reduced to **50 %** of the total amount by weight of biodegradable municipal waste produced in 1995 or the latest year before **1995** for which standardised Eurostat data is available;
- not later than **16 July 2016**, biodegradable municipal waste going to landfill must be reduced to **35 %** of the total amount by weight of biodegradable municipal waste produced in 1995 or the latest year before **1995** for which standardised Eurostat data is available.

Member States which in 1995 or the latest year before 1995 for which standardised Eurostat data is available put more than 80 % of their collected municipal waste to landfill may postpone the attainment of the targets set out above by a period not exceeding four years.

Figure 1

Landfill directive targets



Note: Countries that landfilled more than 80 % of their municipal waste in 1995 can extend the deadlines shown in the above diagram by four years.

The first target can therefore be extended to 2010, the second to 2013 and the third to 2020. The main implication of the targets is that there is an absolute limit placed on the quantity of biodegradable municipal waste that can be landfilled by specific target dates. This means that if BMW production continues to grow, increasing quantities will need to be diverted away from landfill.

1.4. Approach

Information on biodegradable municipal waste management practices and strategic approaches to the management of biodegradable municipal waste was collected initially from the ETC/W consortium countries and regions (Austria, Denmark, Ireland, Catalonia and Baden-Württemberg) by way of a questionnaire. The intention was to gather sufficient information so that the flow of biodegradable municipal waste (i.e. the amount being produced, how it is collected and how it is managed) could be described for each country and region. Information on strategic approaches to the management of biodegradable municipal waste was also gathered so that the instruments used could be evaluated in respect to their relative success in diverting biodegradable municipal waste away from landfill.

Following analysis of the information received from the consortium countries/regions, a simplified version of the questionnaire was prepared and sent out to each EEA National Reference Centre for Waste (NRC/W) asking for summary information on biodegradable municipal waste flows, along with information on the various strategies and instruments employed for the management of biodegradable municipal waste. Responses were received from all countries surveyed except Iceland, Luxembourg and Spain. Information about Spain was obtained from Junta de Residuos, Catalonia (partner in ETC/W consortium). In several cases, the information supplied was insufficient to enable analysis and requests for further information and clarification were issued. Information supplied was then used to prepare a **BMW management status sheet** for each country. These **status sheets** can be downloaded from www.eea.eu.int.

Information on technology and market issues was gathered by designing a pro-forma which was to be completed for each technology type. A companion report on technology and market issues can be downloaded from www.eea.eu.int.

2. Waste definitions and measuring progress towards the targets

2.1. Definition

Municipal waste is defined by Article 2 (b) of the landfill directive as follows:

‘Municipal waste’ means waste from households, as well as other waste, which because of its nature and composition is similar to waste from households.

Biodegradable waste is defined by Article 2 (m) of the landfill directive as follows:

‘Biodegradable waste’ means any waste that is capable of undergoing anaerobic or aerobic decomposition, such as food and garden waste, and paper and paperboard.

There is no specific definition provided for biodegradable municipal waste, the subject of the targets set by Article 5 of the Directive. However, combining the above definitions provides the following definition:

‘Biodegradable municipal waste’ means biodegradable waste from households, as well as other biodegradable waste, which because of its nature and composition is similar to biodegradable waste from households.

In the EEA Report ‘Household and Municipal Waste: Comparability of Data in EEA member countries’ (EEA, 2000), the following conclusions were made in relation to the comparability of data on household and municipal waste in Europe:

‘Total household waste cannot be compared between **all** member countries. This is simply due to the fact that some countries do not provide sufficient information on all waste categories produced by households’.

‘Total municipal waste cannot be compared between **all** member countries due to differences in the kind of waste collected by different municipalities. Data and information on municipal waste must therefore be expected to be incomparable by nature’.

The report goes on to remark, in relation to municipal waste, that ‘there has been a general convergence between the various definitions in relation to the **type** of waste that is considered under the heading municipal — waste type is generally understood to mean household-type waste, meaning that industrial-type wastes are not included. Perhaps, in the long term, and in light of the introduction of private collection schemes in many countries, the definition that is provided in the landfill directive is the most practical from the point of view of comparing one country to another as it simply defines municipal waste as household-type waste from any source and is silent on the question of collection’.

There is clearly a problem in comparing historical data on municipal waste arisings in different countries. **This problem also applies to comparing historical data on biodegradable municipal waste arisings.**

Therefore, to attempt to improve the comparability of data collected, the following operational definition was used in this study, which follows the approach adopted in the municipal and household waste survey conducted by ETC/W in 1998:

Biodegradable municipal waste = bagged biodegradable municipal waste + separately collected biodegradable municipal waste + bulky biodegradable municipal waste.

Where:

Bagged biodegradable municipal waste is the **biodegradable fraction of mixed waste** collected door to door on a regular basis (every day, every week, every two weeks etc.) from households

and other sources such as commerce and trade activities, office buildings, institutions (schools, government buildings etc.) and small businesses.

The biodegradable fraction of mixed waste is the food, garden, paper and paperboard, textiles, wood and other miscellaneous biodegradable content of the waste collected.

Separately collected biodegradable municipal waste is food, garden, paper and paperboard, textiles, wood and other miscellaneous biodegradable wastes **separately collected** from households **and** other sources such as commerce and trade activities, office buildings, institutions (schools, government buildings etc.) and small businesses. Separately collected waste also includes those fractions mentioned above which are delivered to civic waste facilities, bring banks, recycling centres etc.

Bulky biodegradable municipal waste is the biodegradable fraction of bulky waste collected from households and other sources such as commerce and trade activities, office buildings, institutions (schools, government buildings etc.) and small businesses. This includes bulky biodegradable waste delivered to civic waste facilities, bring banks, recycling centres etc.

The biodegradable fraction of bulky waste is made up of materials such as wooden furniture etc. Bulky garden waste is reported under the heading 'separately collected food and garden waste'.

2.2. Establishing a baseline for the targets

The baseline against which the targets are to be measured is 1995 or the latest year before 1995 for which standardised Eurostat data is available. There is an immediate problem in setting a baseline for individual countries because countries did not report biodegradable municipal waste quantities for 1995 or earlier years. In addition, as stated above, data on municipal waste must, by its nature, be expected to be incomparable. However, Eurostat has conducted a preliminary evaluation of its standardised data on household and municipal waste and has developed a set of statistics for EEA member countries. The preliminary data is presented in Table 1, along with supporting footnotes and remarks.

Eurostat baseline data for BMW landfilled

Table 1

Country	Year	Managed MW ¹⁾	Managed BMW ²⁾	Separately collected and recovered BMW ³⁾	MW incinerated	BMW landfilled ⁴⁾
		Ktonnes	Ktonnes	Ktonnes	Ktonnes	Ktonnes
Austria ⁵⁾	1995	2644	1745	791	431	523
Belgium	1995	5014	4312	425 ⁶⁾	1490	2397
Denmark	1995	2591 ⁷⁾	2560	641	1466	453
Finland	1994	2100 ⁷⁾	1890	0	50	1840
France	1995	34700	27760	220	10352	17188
Germany	1993	40017	28700		8552	20148
Greece	1990	3000	2688	0	0	2688
Ireland	1995	1550	1073	60	0	1013
Italy ⁸⁾	1996	24524 ⁷⁾	21655		1572	20083
Luxembourg	1995	278	160	0	126	34
Netherlands	1994	8161 ⁷⁾	7280	2523	2192	2565
Portugal	1995	3884	3301		6	3295
Spain	1995	14914	11633	2117	693	8823
United Kingdom	1995	29000 ⁹⁾	21460		2200	19260
Sweden	1994	3200	2656	400	1300	956

1) Municipal waste managed: MW generated (=collected) + import — export.

2) Biodegradable municipal waste is calculated from 'Municipal waste managed' minus the 'non-biodegradable' fraction. These waste-fractions are calculated with the help of the given composition of municipal waste. The non-biodegradable fractions concerned here are glass, plastic and metal. (In some cases, plastics may be considered to be biodegradable). Figures on the composition of municipal waste are not always from the same year as the waste-figures, or on household waste instead of municipal waste. For municipal waste incinerated no estimations are made for the biodegradable and non-biodegradable fraction. This could be done with the figures on the composition of municipal waste.

3) Food and garden waste, paper, textile, wood, oil and fat.

4) Calculated as follows: managed BMW — separately collected and recovered BMW — incinerated MW.

5) Household waste.

6) Different years (1995 or <) because of separate data provision of the different regions (Flanders, Walloon, Brussels).

7) Sum of treatment and disposal of municipal waste.

8) Latest year before 1995 is 1985.

9) Municipal waste generated.

The ETC/W, as a result of the surveys conducted for this project, has also developed baseline data for each country where sufficient data was provided. Where data has not been reported for 1995, the data for the year closest to 1995 has been chosen. This data is presented in Table 2.

Table 2 ETC/W baseline data for BMW landfilled

Country/region	Year	MW produced	BMW produced	BMW landfilled
		Ktonnes	Ktonnes	Ktonnes
Austria	1995	2644	1495	302
Belgium (Flanders)	1995	2890	1671	623
Denmark	1995	2787	1813	205
Finland	1994	2100	1664	1 085
France	1995	36200	15746	5 988
Germany	1993	43486	12000 ¹⁾	N/A
Germany (Baden-Württemberg)	1995	18300	5859	2 502
Greece	1997	3900	2613	2 324
Iceland	1995	N/A	N/A	N/A
Ireland	1995	1503	990	903
Italy	1996	25960	9170	6 821
Luxembourg	1995	N/A	N/A	N/A
Netherlands ³⁾	1995	7105	4830	1 365
Norway	1995	2722	1572	1 069
Portugal	1995	3340	N/A	N/A
Spain ²⁾	1996	17175	12196	N/A
Spain (Catalonia)	1995	2834	1985	1 481
Sweden	1998	4000	N/A	N/A
United Kingdom ⁴⁾	1996/97	25980	16366	14 675

1) Biodegradable waste from households.

2) Plan Nacional De Residuos Urbanos (2000–06).

3) Figures relate to waste from households only.

4) England and Wales only.

N/A: Information not available

2.3. Measuring progress towards the targets

An agreed approach is required for measuring progress towards the targets set by the landfill directive for biodegradable municipal waste. This requires agreement on the following items:

- the definition of biodegradable municipal waste — a common understanding of the term is required;
- a set of baseline figures against which progress will be measured; and
- a standard approach for tracking changes in biodegradable municipal waste produced.

2.3.1. Definition

The operational definition provided in Sub-Section 2.1 above is recommended for the purpose of gathering data on biodegradable municipal waste. There is, however, a requirement for more detailed descriptions of the actual waste types to be considered as well as guidelines on how to establish the composition of the bagged (mixed) waste component. However, the approach recommended is considered to be reasonably pragmatic and workable.

2.3.2. Baseline data for 1995

The data set out in Table 3 below is presented as a proposed operational baseline for biodegradable municipal waste production in 1995, subject to the agreement of each EEA member country and Eurostat. These are based on the operational definition set out above and have been calculated from the data supplied to ETC/W by each member country. Where a member country supplied insufficient data, the Eurostat estimate (see Table 1 above) was used.

Proposed Baseline data for BMW produced and landfilled in 1995 (1)

Table 3

Country/region	Year	MW produced	BMW produced	BMW landfilled
		Ktonnes	Ktonnes	Ktonnes
Austria	1995	2 644	1 495	302
Belgium ¹⁾	1995	5 014	4 312	2 397
Belgium (Flanders)	1995	2 890	1 671	623
Denmark	1995	2 787	1 813	205
Finland	1994	2 100	1 664	1 085
France	1995	36 200	15 746	5 988
Germany ¹⁾	1993	40 017	28 700	20 148
Germany (Baden Württemberg)	1995	18 300	5 859	2 502
Greece ¹⁾	1990	3 000	2 688	2 688
Iceland	1995	N/A	N/A	N/A
Ireland	1995	1 503	990	903
Italy	1996	25 960	9 170	6 821
Luxembourg ¹⁾	1995	278	160	34
Netherlands ³⁾	1995	7 105	4 830	1 365
Norway	1995	2 722	1 572	1 069
Portugal ¹⁾	1995	3 884	3 301	3 295
Spain ¹⁾	1995	14 914	11 633	8 823
Spain (Catalonia)	1995	2 834	1 985	1 481
Sweden ¹⁾	1994	3 200	2 656	956
United Kingdom ³⁾	1996/97	25 980	16 366	14 675

1) Source: Eurostat.

2) Figures relate to waste from households only.

3) England and Wales only.

N/A: Information not available

2.3.3. Tracking changes in BMW production and management

An agreed approach to tracking changes in the quantities of biodegradable municipal waste produced and the fate of the waste is required so that a consistent approach is adopted within the European Community. An approach based on the Summary Flow Sheet used to gather data during the course of this study is recommended.

There is, however, a need for further guidelines on waste types to be included under the main headings (food, garden, paper etc.) and guidelines on the conduct of waste composition analysis of the mixed municipal waste stream.

(1) Where figures were not available from the ETC/W returns, the relevant Eurostat data was used.

3. Existing management practices in Europe

3.1. Introduction

This section provides an overview of:

- biodegradable municipal waste arisings in Europe ⁽²⁾;
- existing biodegradable municipal waste (BMW) management practices in Europe; and
- projections of biodegradable municipal waste arisings for each country.

Landfill of BMW varies widely from one country to another. This means that some countries, such as Denmark, Austria and the Netherlands, have already reduced their reliance on landfill to the point that the targets set by the Directive have effectively been met. Other countries, such as Italy, the United Kingdom and Ireland, still send most of their BMW to landfill and have a long way to go to reach the targets.

It is therefore important to document the practices in countries with low levels of BMW going to landfill, so that other countries can benefit from this information when formulating their own strategies. However, it is also important to note that there is little room for complacency in countries that currently divert large quantities of biodegradable municipal waste away from landfill. Even relatively modest growth in the production of biodegradable municipal waste between now and 2016/2020 will require planning for significant additional 'landfill diversion' capacity above that which is currently available ⁽³⁾.

3.2. Overview

Table 4 provides an overview of BMW production in the various countries and regions that supplied information. Total tonnage produced in 1995 (the baseline year for the landfill directive) and per capita production are provided. As can be seen, per capita production ranges from 0.16 tonnes per person for Italy up to 0.36 tonnes per person for Norway. Per capita production of BMW is a key indicator for tracking progress towards the achievement of the landfill directive targets, both at national and European level. Average production per capita for these countries is 0.30 ± 0.06 tonnes per annum. While there is a relatively wide range between the highest and lowest values, the overall variation is 20 % of the average, which suggests, overall, that variations between different countries may not be so high. This is probably because biodegradable municipal waste is, generally, waste produced from the daily or routine activities of households and businesses which may not vary that significantly from one country to another. However, in order for per capita production figures to be a truly reliable comparative indicator, each country should use the same definition for both municipal waste and biodegradable municipal waste, which is currently clearly not the case.

(2) Europe' in this report means 'EEA member countries'.

(3) This, of course, could be offset by successful waste prevention and minimisation programmes; however, success to date in relation to waste prevention in the municipal sector has been limited, with gross quantities of municipal waste continuing to rise in most countries.

Summary of BMW production in countries and regions surveyed

Table 4

Country/region	BMW produced in 1995 (tonnes)	BMW production/capita (tonnes/person)
Austria	1 495 000	0.19
Belgium (Flanders)	1 671 108	0.28 ¹⁾
Denmark	1 813 283	0.35
Finland (1994)	1 664 000	0.33
France	15 746 000	0.27
Germany (1993)	28 700 000	0.35
Greece (1997)	2 613 000	0.25
Ireland	990 242	0.27
Iceland	N/A	N/A
Italy (1996)	9 170 530	0.16
Luxembourg	N/A	N/A
Netherlands ³⁾	4 830 000	0.31
Norway	1 571 607	0.36
Portugal	N/A	N/A
Spain ²⁾ (1996)	12 196 099	0.31
Spain (Catalonia)	1 984 912	0.32
Sweden	N/A	N/A
United Kingdom ⁴⁾ (1996/97)	16 366 000	0.31

1) Population of Flanders at 1 January 1999 = 5 926 838.

2) Plan Nacional De Residuos Urbanos (2000–2006).

3) Figure relates to waste from households only.

4) England and Wales only.

N/A: Information not available

The management of BMW in the countries and regions surveyed is summarised in Figures 2 and 3. Figure 2 presents an overview, for the most recent year for which reliable data is available, of BMW collection practices in the various countries and regions surveyed. As can be seen, the percentage of BMW separately collected ranges from nearly 70 % in Flanders to 5 % in Catalonia. While there would appear to be relatively low variation in the quantities of BMW produced per capita, as illustrated in Table 4 above, there is considerable variation in the collection of BMW. Flanders, Austria, the Netherlands, Denmark and Norway, all report over 30 % separate collection of BMW.

Figure 3 and Table 5 provide an overview, for the most recent year for which reliable data is available, of BMW waste management practices in the countries and regions surveyed. This gives an indication of the range and extent of practices applied. For instance, countries and regions such as Denmark, the Netherlands, Flanders and Austria, which have low reliance on landfill, employ a mixture of incineration, composting and recycling to treat BMW produced. Reliance on landfill for the treatment of BMW ranges from as low as 5 % in Denmark to over 80 % in the United Kingdom and Ireland.

Figure 2 Collection practice in countries and regions surveyed

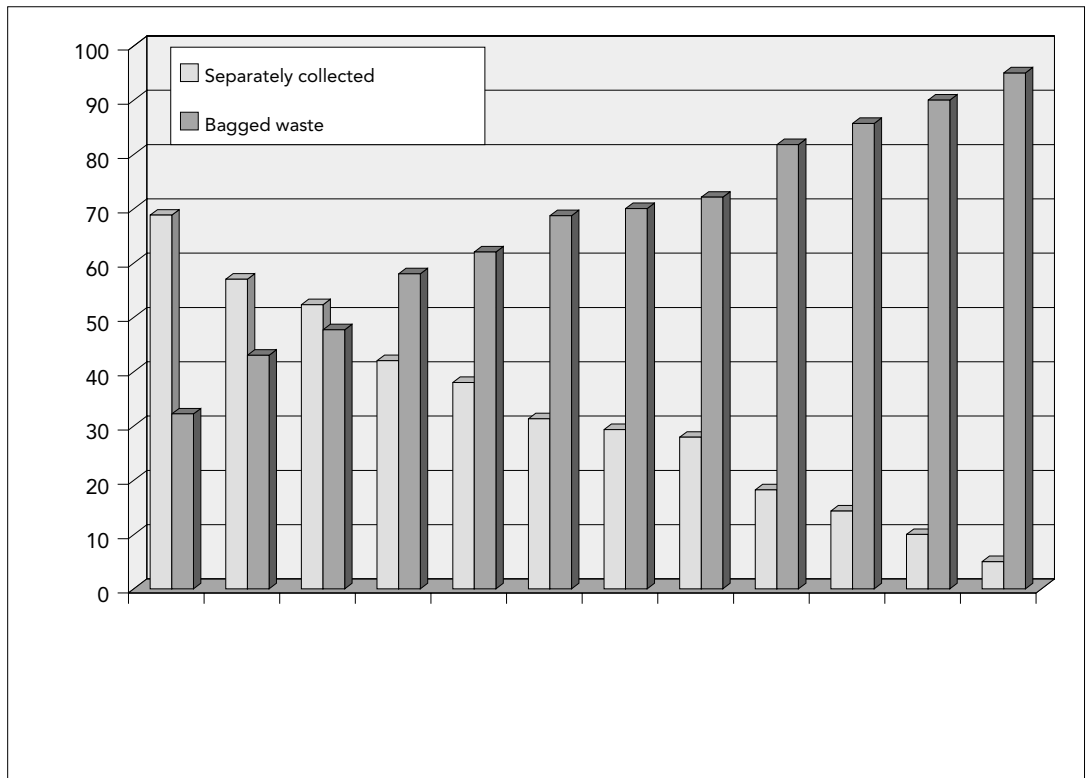
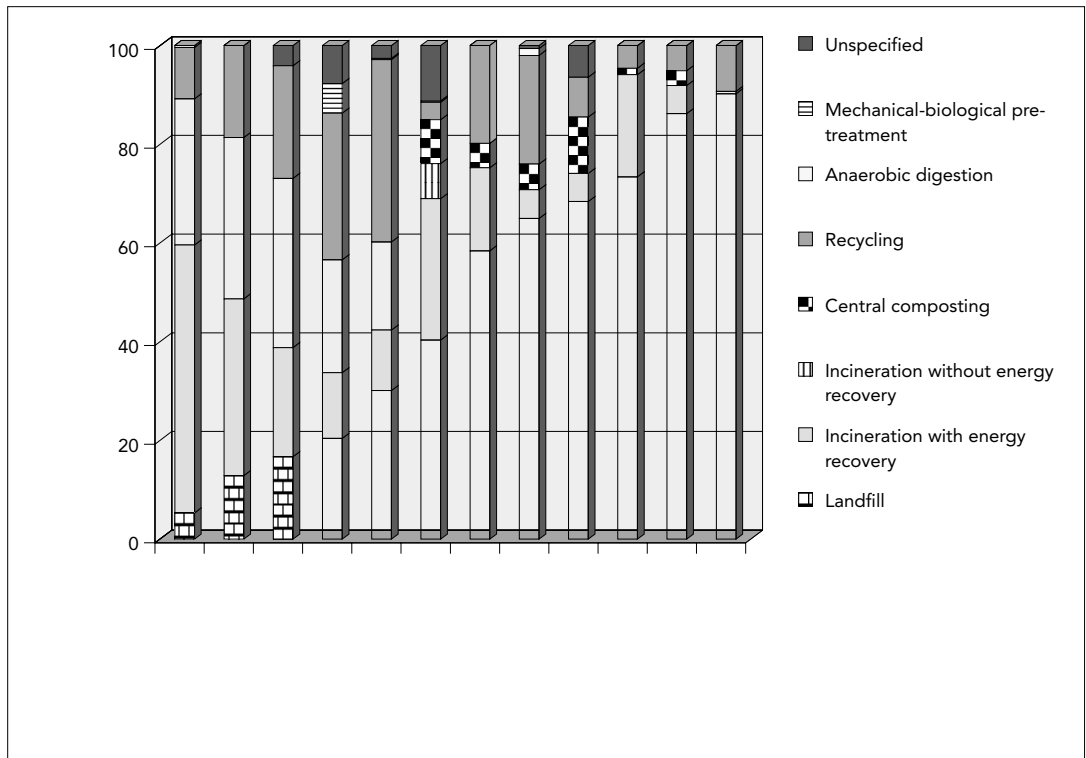


Figure 3 Management of BMW in countries and regions surveyed



Management of BMW in countries and regions surveyed

Table 5

	BMW management routes (% of total BMW produced)							
	Landfill	Incineration with energy recovery	Incineration without energy recovery	Central composting	Recycling	Anaerobic digestion	Mechanical-biological pre-treatment	Unspecified
Austria (1996)	20.4	13.3	0	22.9	29.7	0	6.0	7.7
Belgium (Flanders) (1998)	16.7	22.1	0	34.3	22.8	0	0	4.1 ¹⁾
Denmark (1998)	5.3	54.3	0	29.6	10.4	0.4	0	0
Finland ²⁾ (1997)	64.9	5.8	0	5.2	22.0	1.4	0	0.6
France ³⁾ (1998)	40.3	28.6	7.1	8.9	3.5	0.3	0	11.2
Germany	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Germany (Baden-Württemberg) (1998)	30.2	12.3	0	17.9	37.1	0	0	2.6 ⁴⁾
Greece	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iceland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ireland (1998)	90.3	0	0	0.5	9.3	0	0	0
Italy (1997)	68.4	5.7 ⁵⁾	0	11.4	8.1	0	0	6.4
Luxembourg	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Netherlands (1998)	13.1	36.5	0	33.3	19.0	0	0	0
Norway (1997)	59.0	17.0	0	5.0	20.0	0	0	0
Portugal	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Spain	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Spain (Catalonia) (1998)	73.4	20.7	0	1.3 ⁶⁾	4.6	0	0	0
Sweden	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
United Kingdom ⁷⁾ (1998/99)	86.2	5.7	0	3.0	5.1	0	0	0

1) This figure refers to the percentage of BMW which is managed through re-use.

2) 0.58 % refers to 10,320 tonnes of Packaging and Wood waste separately collected in 1997, for which storage is the only known management route.

3) Waste management routes for France only account for 88.8 % of the total BMW produced. The remaining 11.2 % is accounted for by separately collected garden waste, the management route of which is unspecified or unknown.

4) This figure may include a fraction managed by anaerobic digestion.

5) This figure refers to incineration with/without energy recovery.

6) This figure is accounted for by 0.43 % central composting and 0.79 % mass composting.

7) England and Wales only.

N/A: Information not available

The three principal routes for diverting BMW away from landfill are incineration with energy recovery, central composting and recycling. Countries and regions with low landfill rates for BMW tend to employ a mixture of incineration and central composting, along with recycling, mainly of paper.

3.3. BMW management status sheets

Completed summary flow sheets for each country can be downloaded from www.eea.eu.int. Information supplied varied significantly from country to country with some countries supplying limited information. A management status sheet was prepared for each country and region that supplied sufficient information for this to be done. These sheets can also be downloaded from www.eea.eu.int. Each sheet contains summary information on:

- existing collection and management practices;
- future projections of BMW arisings;

- maximum quantity that can be landfilled; and
- quantities requiring diversion from landfill based on future projections.

Projections were estimated for the following scenarios:

- 1 % annual growth;
- 2 % annual growth;
- 3 % annual growth;
- average projected growth in GDP between 1995 and 2015; and
- average projected growth in private consumption between 1995 and 2015.

Data for average projected growth in GDP and private consumption was abstracted from a baseline scenario developed by the Dutch Environmental Research Institute (RIVM) and used previously by the Topic Centre for developing projections of household, paper and glass arisings (European Environment Agency, 1999).

3.4. Key information gaps

A fundamental requirement for the preparation of a strategy for meeting the targets set out in the landfill directive is a comprehensive understanding of the quantities of BMW being produced and its fate, i.e., what happens to it once it has been collected for management. The summary sheets prepared for data collection within this project provide a guideline for the type of information required to establish this information. As stated above, information supplied varied significantly from country to country with some countries supplying limited information. This suggests that significant effort is required on the part of certain Member States to establish the basic information on BMW production and management required to prepare a meaningful strategy.

3.5. Future projections and implications

Strategic planning for the landfill directive requires an appreciation of the possible implications of growth in BMW production during the lifetime of the Directive. Several scenarios have been considered for each country, as set out above, with the results presented in the BMW Management Status Sheets, which can be downloaded from www.eea.eu.int. As with all projections into the future, the results must be treated with a degree of caution; however, they give an indication of the types of challenges various Member States might face in the coming years.

As an example, Table 6 presents an overview of projected quantities for each country for the year 2016, based on the assumption that BMW quantities will grow in line with projected growth in private consumption. As can be seen, the key impact will be a significant increase for all countries in the quantity of BMW requiring diversion away from landfill, because the landfill directive imposes an absolute restriction on the quantity of BMW that can be landfilled. For instance, countries that currently landfill relatively modest quantities of BMW, such as Denmark and the Netherlands, may have to plan for a significant increase in the quantities of BMW requiring treatment by alternative routes to landfill, particularly if it is planned to maintain low landfilling rates. Figure 4 illustrates this point by providing a comparison between quantities currently diverted away from landfill (where available) and quantities that will require diversion away from landfill in the event that future growth in BMW is in line with growth in private consumption.

Implications of growth in BMW up to 2016

Table 6

Country/region	BMW baseline — 1995	Projected quantity produced in 2016	Maximum quantity to landfill in 2016 ¹⁾	Quantity to be diverted from landfill in 2016 ²⁾
	(Million tonnes)			
Austria	1.495	2.17	0.523	1.647
Belgium (Flanders)	1.671	2.39	0.585	1.805
Denmark	1.813	2.79	0.635	2.155
Finland	1.664	2.72	0.582	2.138
France	15.746	24.36	5.511	18.849
Germany	28.7	44.381	10.045	34.336
Germany (Baden Württemberg)	5.859	9.060	2.05	7.01
Greece	2.688	4.756	0.941	3.815
Iceland	N/A	N/A	N/A	N/A
Ireland	0.990	1.87	0.346	1.524
Italy	9.170	12.984	3.209	9.775
Luxembourg	0.16	N/A	0.056	N/A
Netherlands	4.830	7.699	1.691	6.008
Norway	1.572	1.712	0.5502	1.162
Portugal	3.301	6.160	1.155	5.005
Spain	11.633	20.293	4.071	16.222
Spain (Catalonia)	1.985	3.46	0.695	2.765
Sweden	2.656	3.948	0.9296	3.0184
United Kingdom	19.66	33.60	6.881	26.719

1) 35 % of the Baseline.

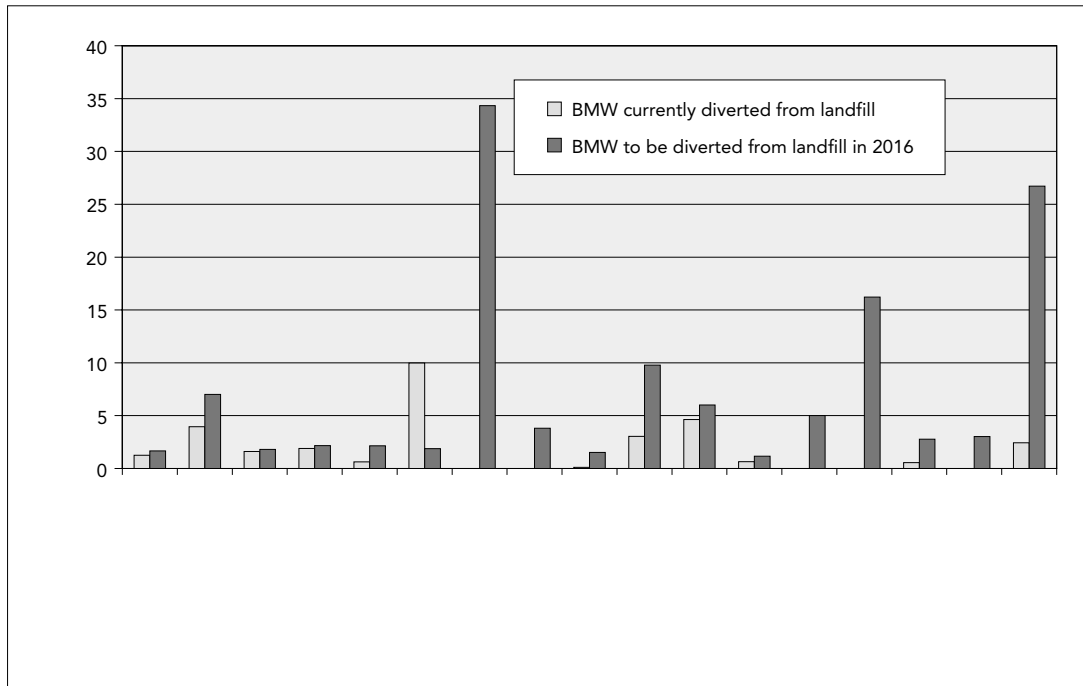
2) Projected quantity produced — maximum quantity permitted to landfill.

N/A has been inserted where no figure for private consumption was available

Clearly, any increases in BMW production during the lifetime of the Directive will have profound effects on the requirement for treatment routes other than landfill. A fundamental part of each countries strategy should be a comprehensive analysis of future trends in BMW production between now and 2016 (or 2020 in the case of countries seeking the four year extension) so that adequate capacity can be planned well in advance of requirements. National strategies will also need to be sufficiently flexible to respond to changes such as economic and demographic changes that may have an effect on the quantities of BMW produced. This will require, among other things, the development of implementation plans and on-going review of such plans.

Figure 4

Estimated current quantities of BMW being diverted from landfill and estimated quantities requiring diversion by 2016



Note: Figures for BMW currently diverted from landfill not available for Germany, Greece, Portugal, Spain or Sweden.

4. Strategies and instruments for diverting BMW away from landfill

4.1. Introduction

The typical flow of biodegradable municipal waste is illustrated schematically in Figure 5. It can be broken down into four specific phases:

- Phase 1 — production
- Phase 2 — presentation ⁽⁴⁾, collection, transfer and movement
- Phase 3 — treatment
- Phase 4 — end-use/final destination (beneficial use or disposal)

When considering the various strategies and instruments available to assist in the diversion of biodegradable municipal waste (BMW) away from landfill, each phase requires analysis because interventions across the board from production to final destination will probably be required in order to achieve the required landfill diversion rates. It is also useful to consider at what point in the waste chain a particular instrument or strategy fits so that each part of the waste chain is considered and addressed when preparing a strategy for diversion of waste away from landfill.

Phase 1 is the production of biodegradable municipal waste. In many ways, this is the most difficult phase to tackle as it requires the implementation of successful waste prevention and waste minimisation measures. However, it also requires the development of a comprehensive understanding of the composition of the waste stream so that, for instance, it is known what proportion of the waste stream consists of food waste, paper, cardboard, newspaper etc. and how seasonal and other factors effect composition. Strategies and instruments relevant to Phase 1 therefore include waste prevention initiatives such as public education programmes, school campaigns, consumer awareness programmes, waste reduction initiatives and re-use programmes, and waste management initiatives such as waste composition surveying.

Phase 2 involves the presentation, collection and transfer/movement of waste. Many countries have laws in place which enable municipal authorities to specify how waste can be presented for collection, for instance, the size and type of receptacle to be used. Restrictions can also be placed on the types of waste acceptable for collection. There is considerable scope, therefore, for controlling what enters the waste chain by controlling how waste is presented for collection. Phase 2 is of central importance in relation to the diversion of waste away from landfill because the manner in which waste is collected has a profound effect on the treatment options available.

Phase 3 consists of the various treatment options available for managing the biodegradable fraction of municipal waste. As stated above, the manner in which this waste fraction is collected determines, to a large extent, the options which are available to deal with this waste stream. Key strategies and instruments relevant to Phase 3 include those that are designed specifically to divert waste away from landfill, such as bans or restrictions on the type of waste that can be landfilled and waste taxes such as landfill taxes.

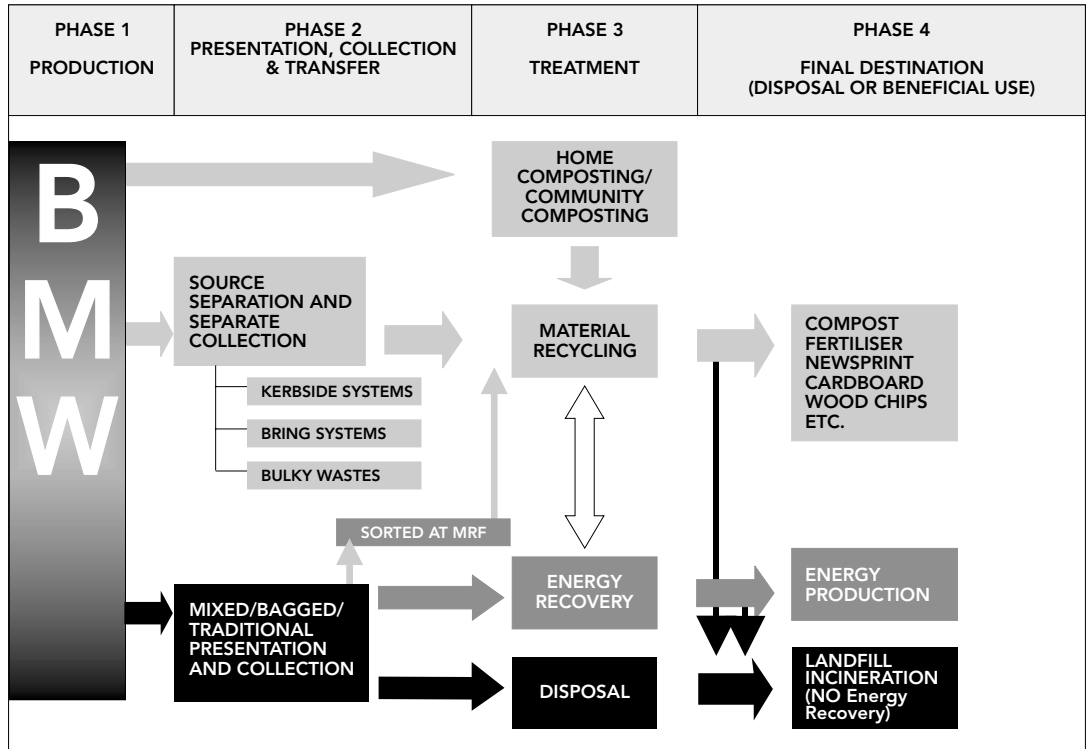
Phase 4 is the final destination or end use of the material. Key instruments here relate to ensuring that markets and outlets are available for materials diverted from landfill to various recovery routes.

Table 7 provides an overview of the strategies and instruments reported by the countries examined to assist in diverting BMW away from landfill. These instruments include separate collection, incinerating a significant proportion of the biodegradable municipal waste

(4) Presentation means, in this context, **preparation for collection** and is the step in the waste chain between generation and collection of waste with specific requirements, e.g. use of specific types of containers, pre-sorting of wastes.

fraction, banning or restricting the landfilling of BMW, fiscal instruments and home composting. It is evident that countries that are presently diverting significant quantities of BMW away from landfill, are not reliant on just one instrument but have adopted a range of instruments in order to maximise landfill diversion rates.

Figure 5 Summary flow chart for biodegradable municipal waste



Strategies and instruments in use

Table 7

Instrument/ country	Separate collec- tion ¹⁾	Signifi- cant quanti- ties incin- erated (> 20 %)	Tax on waste going to landfill	Ban on landfilling of BMW	Other fiscal instru- ments	Home compos- ting
Austria	√	X	√	X	√ ²⁾	√
Belgium (Flanders)	√	X	√	√ ³⁾	√ ⁴⁾	√
Denmark	√	√	√	√	√ ⁵⁾	√
Finland	√	X	√	To be introduced on 1/1/05	√	√
France	√	X	√	To be introduced in 2002	N/A	N/A
Germany	√	√ ⁶⁾	X	To be introduced in 2005	X	√
Baden- Württemberg	√	X	X	To be introduced in 2005	X	√
Greece	√	X	X	C	N/A	N/A
Iceland	N/A	N/A	N/A	N/A	N/A	N/A
Ireland	√ ⁷⁾	X	X	X	X	√ ⁸⁾
Italy	√	X	√	To be introduced in 2001	N/A	√
Luxembourg	N/A	N/A	N/A	N/A	N/A	N/A
Netherlands	√	√	√	√	N/A	N/A
Norway	√	X	√	To be introduced on 1/1/01 ⁸⁾	√ ⁹⁾	N/A
Portugal	√	N/A	X	X	N/A	N/A
Spain	√	N/A	N/A	N/A	N/A	N/A
Catalonia	√	√	X	X	√ ¹⁰⁾	N/A
Sweden	√	√	√	To be introduced in 2005	√ ¹¹⁾	√
UK (England & Wales)	√	X	√	To be introduced	X	√

- 1) The quantities and fractions being separately collected vary significantly between countries.
- 2) The cost of collection from households is based on the quantity collected. Thus there are reduced costs for those households that carry out home composting.
- 3) Ban on the landfilling of separately collected paper and paperboard, separately collected food and garden waste and municipal waste from households.
- 4) There are higher collection costs for unsorted waste.
- 5) Some municipalities charge less where home composting is carried out.
- 6) Exact quantity of BMW incinerated is not known but is expected to be greater than 20 %.
- 7) Pilot scale at present.
- 8) One county has introduced this since 1995.
- 9) Charges for waste collection from households are based on quantities collected. There are lower collection fees for those that carry out home composting.
- 10) Subsidies are available for the promotion of separate collection. There are also fiscal measures to discourage the landfilling of waste.
- 11) Investment grants are provided for the development of new biological treatment plants. There are also reduced collection fees for households that carry out home composting or households that participate in communal composting schemes.

(Key √ — in use; C — not in use; N/A — no information available)

In developing a strategy, it is important to examine each link in the waste chain and to consider at what point particular strategies and instruments might apply. In addition, it is important to examine the flow of biodegradable waste through the waste chain and to consider how the application of a specific instrument may influence decisions or options in subsequent phases.

Table 8 lists typical strategies and instruments and links them to the particular phases in the waste chain (see Figure 5). As can be seen in a number of the cases, some of the instruments have a role to play in each of the phases e.g., public education, fiscal measures and producer responsibility initiatives and obligations, whereas others are only applicable to a particular phase, for example, waste prevention and minimisation.

Table 8 Strategies and instruments appropriate to different phases

Instrument/phase	Phase 1 Production	Phase 2 Presentation, collection, transfer & treatment	Phase 3 Treatment	Phase 4 Final destination (disposal or beneficial use)
Waste prevention and Minimisation	√			
'Greener' shopping	√			
Home composting	√			
Public education	√	√	√	√
Fiscal measures	√	√	√	√
Producer responsibility initiatives and obligations	√	√	√	√
Use of presentation by-laws		√		√
Requirement for separate collection		√	√	√
Significant quantities incinerated			√	
Ban on landfilling of BMW		√	√	√
Ban on landfilling of specific BMW fractions		√	√	√
Waste taxes		√	√	√
Identification and development of end markets		√	√	√

Strategies and instruments appropriate to each phase are discussed in the following sub-sections. A number of case studies are also presented in this section for countries and regions that have succeeded in diverting large quantities of BMW away from landfill.

4.2. Phase 1 — production

Phase 1 of the waste chain relates to the production of biodegradable municipal waste. As the quantity produced increases, the management responses required become more critical. Thus, in the long term, one of the most important instruments that can be used to reduce the quantity of BMW which is consigned to landfill is preventing or minimising the generation of this waste in the first instance. BMW waste prevention and minimisation initiatives apply mainly to the paper and cardboard fraction with home composting the main route through which food and garden waste can be prevented from entering the municipal waste stream.

Waste prevention and minimisation sits at the top of the EU waste hierarchy as being the most desirable option for dealing with waste. A number of different methods can be employed to encourage the general public and commercial enterprises to reduce the amount of waste that they produce. Such measures include:

- consumer awareness: encouraging individuals to become 'greener' shoppers, e.g. only buy what you need, buy loose products if possible, choose products which have minimal packaging, buy concentrated products as they use less packaging, choose products in reusable or returnable packaging and products that come in recycled or recyclable materials;
- public education: Public education is a very important measure to be employed to encourage the general public to reduce the quantity of waste that they produce.
- Separation at source: Encouraging householders to separate their waste into the various different fractions, e.g. paper and paperboard, food and garden waste, textiles and wood;
- home composting: Encouraging householders to home compost the relevant biodegradable fractions of their municipal waste;
- fiscal instruments: The use of fiscal measures to encourage householders to reduce the quantity of waste that they produce has proven to be very beneficial. These have included charges for waste collection and treatment based on the quantity of waste put out for collection;

- producer responsibility initiatives and obligations: These are initiatives or obligations undertaken by those involved in the manufacture, distribution and sale of products. These can be effective tools for making producers take greater responsibility for goods at the end of their lives. These initiatives can include reductions in the quantity of packaging required, reductions in the polluting potential of the packaging i.e., reductions in the heavy metal content of the packaging or increasing the quantity of recycled material used in the products. Producer responsibility programmes can be either voluntary agreements between public authorities and bodies representing waste producers such as trade associations or mandatory measures imposing obligations on specific producers.

Most countries appear to prefer the use of voluntary agreements. In England and Wales, for instance, the Government has been working with the Newspaper Publishers Association to increase the recycled content of newsprint which in 1999 was approximately 54 %. The newspaper publishers have agreed to commit themselves to the following targets: 60 % recycled content by the end of 2001, 65 % recycled content by the end of 2003 and 70 % recycled content by the end of 2006. These targets will be subject to review in 2001 and 2003 (DETR, 2000). Many of the agreements reached in Member States to facilitate progress towards the targets set by the Packaging Directive are voluntary agreements, backed up with the promise of mandatory measures being introduced in the absence of progress.

While more difficult to tackle than other phases in the waste chain, national strategies should address waste prevention and minimisation as a key area for action and countries should put in place measures to encourage prevention and minimisation as an integral part of the strategy.

4.3. Phase 2 — presentation, collection and transfer/movement

4.3.1. Overview

Phase 2 relates to the presentation, collection and transfer/movement of waste and is, perhaps, the key phase in relation to the management of BMW. Effectively, there are two options: the BMW which is produced can either be managed on site (at or near the place of origin) or off site (away from the place of origin). On-site management relates mainly to either home composting or communal composting.

The manner in which waste is presented for collection for subsequent treatment off-site has a major influence on the options available for managing the waste stream. BMW can either be presented as part of the bagged waste fraction (i.e., mixed waste) or as separate fractions (e.g., paper and paperboard, food waste, garden waste and wood waste).

As mentioned in Section 3 and illustrated below in Table 9, there is considerable variation between countries in relation to the relative quantity of BMW that is separately collected, ranging from nearly 70 % in Flanders to 5 % in Catalonia. Countries that landfill less than 20 % of their BMW separately collect in excess of 40 % of BMW produced. It should be noted that this table presents data for the most recent year for which reliable information is available.

Table 9 Landfilling, separate collection and bagged waste collection rates

Country or Region	Year	% of BMW being consigned to landfill	% of BMW collected as Bagged Waste	% of BMW collected in separate fractions
Austria	1996	20.4	43.0	57.0
Denmark	1998	5.3	58.0	42.0
Ireland	1998	90.3	90.0	10.0
Belgium (Flanders)	1998	16.7	32.2	68.8
Finland	1997	64.9	70.0	29.3
France	1998	40.3	81.8	18.2
Germany	1993	N/A	N/A	23.5 ¹⁾
Germany (Baden-Württemberg)	1998	30.2	62.0	38.0
Greece		N/A	N/A	N/A
Iceland		N/A	N/A	N/A
Italy	1997	68.4	85.7	14.3
Luxembourg		N/A	N/A	N/A
Netherlands ²⁾	1998	13.1	47.7	52.3
Norway	1997	59.0	68.7	31.3
Portugal		N/A	N/A	N/A
UK (England & Wales)	1998/99	86.2	72.1	27.9
Sweden		N/A	N/A	N/A
Spain		N/A	N/A	N/A
Spain (Catalonia)	1998	73.4	95.0	5.0

1) Refers to waste from households only.

2) Refers to waste from households only.

N/A: Information not available

There is, therefore, considerable evidence that widespread separate collection systems are an essential infrastructural requirement for large scale diversion of BMW away from landfill. Of course, the one exception to this would be the diversion of BMW collected as bagged waste away from landfill to incineration with energy recovery; however, such a simplistic solution would probably be in breach of Article 5 of the landfill directive which states that the strategy (to reduce biodegradable waste going to landfill) should include measures to achieve the targets by means of in particular, recycling, composting, biogas production or materials/energy recovery.

The widespread use of separate collection systems is therefore the first step towards the development of a mix of diversion routes such as composting, recycling, biogas production and materials/energy recovery.

4.3.2. Collection of BMW in separate fractions

The main fractions of BMW which can be separately collected are paper and paperboard, food waste, garden waste, textiles and wood. Table 10 lists the different fractions of BMW which are separately collected, and/or delivered to civic waste facilities, by the various countries and regions examined.

Fractions of BMW collected separately

Table 10

Country or region	Paper and paperboard	Food waste	Garden waste	Textiles	Wood
Austria	√	√	√	√	√
Denmark	√	√	√	X	X
Ireland	√	√ ¹⁾	√ ³⁾	√	X
Catalonia	√	√	√	X	X
Baden-Württemberg	√	√	√	√	√
Belgium (Flanders)	√	√	√	√	√
Finland	√	√ ²⁾	√	√	√ ³⁾
France	√	√	√	√	√
Germany	√	√	√	√	√
Greece	√	X	√ ⁴⁾	X	X
Iceland	N/A	N/A	N/A	N/A	N/A
Italy	√	√	√	√	X
Luxembourg	N/A	N/A	N/A	N/A	N/A
Netherlands	√	√	√	√	X
Norway ⁵⁾	√	√	√	√	√
Portugal	√	√ ⁶⁾	√ ⁷⁾	√ ⁹⁾	X
United Kingdom (England & Wales) ⁸⁾	√	√	√	√	X
Sweden	√	√ ⁹⁾	√ ⁹⁾	X	X
Spain	N/A	N/A	N/A	N/A	N/A

1) Pilot scale at present.

2) With varying degree, such biodegradable waste fractions as food and garden waste are composted on-site, and therefore they are not collected separately.

3) Some of the wood waste is used on-site for energy recovery or recycling.

4) Collection has started. At present it is carried out in the area of the existing composting plant.

5) The collection system varies within the country. Regions which have a connection to an incineration plant, most likely do not collect all these fractions separately.

6) To commence in Lisbon in 2001.

7) Is only carried out in some municipalities.

8) Not all local authorities operate separate collection.

9) Is only carried out in some municipalities.

(Key √ — in use; X — not in use; N/A — no information available)

4.3.3. How are these fractions separately collected?

In general, there are three methods used to separately collect biodegradable municipal waste:

- direct from households (kerbside collection);
- use of collection receptacles in close proximity to households (bring banks); and
- delivery direct to civic waste facilities (recycling centres).

Direct from households

In general, there are four different collection receptacles used for the collection of the biodegradable fraction of municipal waste from households; biobins, paper bags, plastic bags (some of these may be biodegradable) and to a limited extent biodegradable bags. Biobins are generally made from plastic and are usually stored along with the collection receptacle used for storing the mixed waste fraction. The size of these bins range in general from 40 litres to 120 litres. Paper bags are often used for the storage of biodegradable municipal waste because the paper bag does not have to be removed prior to composting, as it will degrade during the composting process. This is usually facilitated by passing the bags through a shredder prior to the composting process. In some countries plastic bags of different colours are used for the collection of the different fractions of waste with the bags then being sorted optically in central plants. The disadvantage of the use of plastic bags for the collection of BMW is that the bag has to be removed prior to the composting process. The use of biodegradable bags for the collection of BMW is gaining popularity as, like with paper bags, they can be placed directly into the composting process. An additional advantage is that they

are more durable than paper bags, which tend to disintegrate when they get wet. However, biodegradable bags tend to be more expensive than plastic or paper bags.

The frequency of collection varies between municipalities but is generally weekly or alternative weeks. During the summer, the food and garden waste fraction may need to be collected at greater frequencies in order to prevent nuisances such as, for example, odours etc. from occurring.

A key advantage of collection direct from households is that high participation rates are generally achieved.

Use of collection receptacles in close proximity to households

These usually consist of large containers which are located in close proximity to households in strategically located positions such as beside supermarkets, where householders can bring their separated waste fractions for collection. There is usually a colour-coded container designated to each waste fraction. Paper and paperboard, food waste, garden waste and textiles can all be collected in this way ⁽⁵⁾. In relation to food waste, householders are usually provided with either plastic or paper bags in which they place their food waste, which they then deliver to these collection points. The frequency at which these containers are emptied varies between municipalities and depends upon the fraction of waste that they contain, for example, greater frequencies for food waste. In some countries and regions, e.g. Catalonia, the food waste containers are emptied either on a daily basis or every second day. This frequency may be increased during the summer months to minimise potential nuisances. The receptacles are cleaned at least once in every two week period. This type of collection method is particularly suitable for areas with high residential densities with limited space available for larger containers.

Delivery direct to civic waste facilities (recycling centres)

A civic waste facility, also known as a recycling centre, is a facility at which waste may be directly deposited. In addition to accepting wastes like bottles, cans, batteries and electrical goods, these facilities may also accept paper and paperboard, food and garden waste, textiles and bulky household waste. These facilities are generally more suited for the collection of biodegradable municipal waste from less populated areas, e.g. rural locations, where it may not be economical to collect these fractions directly from the households.

4.3.4. Strategies and instruments in place to encourage source separation and separate collection

A number of different measures can be employed to encourage and increase the rate of separate collection. The following include the main measures that are usually employed:

- legal obligations requiring separate collection;
- the use of presentation by-laws;
- fiscal instruments; and
- sustained public education campaigns.

A combination of these measures is likely to be required if high separate collection rates are to be achieved.

Legal obligations requiring separate collection

A number of countries have introduced legal requirements for the separate collection of the biodegradable fraction of municipal waste. Depending on the country concerned, this obligation may extend to certain specific fractions like food waste and paper and paperboard. For example, in Austria, since 1995, there has been a legal obligation on municipalities to separately collect and treat organic waste from households. Similarly in Catalonia, since July 1999 municipalities with more than 5 000 inhabitants must carry out separate collection of the organic fraction of municipal solid waste. In Denmark, municipalities are legally obliged to collect 40–55 % of newspapers and magazines for recycling. The Danish municipalities are

(5) Some countries do not allow the collection of food waste in this way for public health reasons. Clearly, hygiene and public health concerns must rank highly when planning this type of collection activity.

also required to establish collection systems for food waste from canteens and restaurants that generate more than 100 kg of food waste per week. Since January 1994, all municipalities in the Netherlands have been required to separately collect food and garden waste from households. Dutch municipalities are also required to collect paper and paperboard and textiles separately.

Generally, these obligations are placed on municipalities by central government, with municipalities responsible for implementation. As with all such obligations, their relative success depends to a large extent on sufficient funding as well as the cultural conditions that prevail in a particular country in relation to how different levels of government cooperate with one another.

The use of presentation by-laws

An additional measure which is complementary to the one specified above is the use of by-laws or other legislative means which require householders or other waste producers, such as commercial enterprises and state institutions, to separate specific fractions of their waste and to present them for collection in the manner specified. This usually relates to the type of collection container to be used and the frequencies and dates at which these containers should be put out for collection. In Ireland, for instance, there is a provision under the Waste Management Act of 1996, the primary piece of national legislation in relation to waste, which provides municipalities with the power to pass by-laws specifically in relation to the manner in which waste is to be presented for collection.

Fiscal instruments

These generally include measures relating to the cost of collection and treatment of waste from households and other premises. The net effect of these instruments is to give the waste producer a financial incentive to either put out less waste for collection or to present waste in a manner which makes it more amenable to recovery. In a number of countries, the cost is based on the quantity or weight of waste put out for collection. Thus for those households that recycle a large proportion of their household waste, considerable reductions in costs can be achieved. In addition, where home and/or communal composting is carried out, similar cost savings can be achieved. In some cases, municipalities reduce their collection fees for those households where home composting is carried out e.g., Austria, some municipalities in Denmark, Sweden and Italy. In Flanders, collection costs are higher for unsorted wastes compared to sorted wastes.

Sustained public education campaigns

Public education campaigns are a vital part of the implementation of waste management strategies and plans. These campaigns are aimed at encouraging waste producers to, in the first instance, reduce the quantity of waste which they produce, and secondly to encourage source separation and recovery of waste.

Householders can be encouraged by informing them of the importance of their active participation in source separation schemes and the provision of advice. This can be achieved through the use of newsletters, visiting households and telephone helplines. It is essential that throughout these schemes householders are provided with positive feedback. Many schemes that had high levels of participation in the initial phase and where rates subsequently dropped, the fall-off in participation was primarily due to the lack of follow-up by the relevant municipalities.

4.3.5. Additional considerations

Prior to the commencement of any source separation scheme it is vital that markets and end uses for the products have been identified. This will help identify issues like relevant quality standards that are required to be achieved for certain products and thereby highlight considerations such as the level of contaminants that are acceptable/unacceptable.

4.3.6. Collection of BMW a bagged waste

BMW can also be collected as part of the bagged waste fraction. However, collecting BMW by this method restricts the routes by which it can subsequently be managed. Generally, mixed municipal waste is either landfilled or incinerated, although some countries have experience

in manual and mechanical separation of materials from the mixed waste stream. Due to the problems of contamination, source separation must be considered to be a better management option than attempting to separate out materials from the mixed waste stream.

4.4. Phase 3 — treatment

As illustrated in Figure 5, the treatment options available to treat BMW depend to a large extent on the way in which the waste is collected. The main options available are summarised in Table 11. The most widely used option for diverting bagged waste away from landfill is incineration. Other options include manual or mechanical sorting of the mixed waste stream to recover materials or reduce the organic content, or central composting for mass reduction only. Generally, attempting to recover materials from the mixed waste stream has not met with success due to contamination problems.

Table 11 Options available for diverting BMW away from landfill

Waste stream	Incineration	Gasification	Pyrolysis	Central composting for mass reduction	Composting	Anaerobic digestion	Recycling	Re-use	Manual or mechanical sorting
Wet mixed (bagged waste)	√			√		√			√
Refuse Derived Fuel (RDF)	√	√	√						
Food and garden					√	√			
Food					√	√		√	
Garden					√	√			
Paper	√	√	√		√	√	√		
Textiles	√	√	√				√	√	
Wood	√	√	√				√	√	

The options are considerably broader for separately collected fractions, ranging from relatively simple composting technologies to relatively complex thermal treatment options such as gasification and pyrolysis.

A key issue to address when deciding on the optimum approach to managing BMW and its component waste streams is the availability of markets and outlets for materials recovered from the waste stream. Prior to investing resources in the construction of facilities for recovery of BMW such as composting plants, anaerobic digestion plants or gasification plants, it is vital that end markets and outlets for the products produced have been identified. Market analysis will also help highlight issues such as relevant quality standards that are required to be achieved for certain products.

Key instruments to encourage the diversion of BMW away from landfill include the introduction of bans and restrictions on the landfilling of BMW or specific fractions of BMW, and the use of waste taxes, in particular landfill taxes and taxes that provide a financial incentive to divert waste away from landfill and/or incineration. Practical examples of the use and application of these instruments are presented in the case studies (see Sub-Section 4.6).

4.5. Phase 4 — final destination, end uses and markets

The final link in the chain is the final destination or end-use of the material, which will, to a large extent, be determined by the way in which the material is collected. Bagged waste will, in most cases, either be landfilled or incinerated, with or without energy recovery. Allowing BMW to be collected as bagged waste limits the options available for it further down the waste

chain. However, even in countries with very high separate collection rates, there remains a significant quantity of waste that is, and in all likelihood will, continue to be collected as bagged waste, and management options are required to deal with this. Each country will have to decide, based on its own criteria, what it considers to be the best environmental, economic and political solution to managing this part of the waste stream. Ideally, national strategies should be geared towards reducing the quantities of BMW collected as part of the bagged waste stream, so that it can maximise the potential for recovery of the materials contained within the stream.

Wastes that are separated at source and collected separately have the potential to be recovered and put to beneficial use. However, if inadequate attention is paid to the quality of the recovered materials and to the development and maintenance of reliable markets and outlets for materials recovered from BMW, countries risk the creation of a separate waste management problem. It is therefore vital to address the question of markets and outlets for materials recovered from the BMW waste stream, and to ensure that structures are put in place that guarantee the reliability of these markets and outlets.

4.6. Case studies

A number of case studies are presented below from Denmark, the Netherlands and Flanders. These countries/regions have been chosen for the following reasons:

- less than 20 % of BMW produced is consigned to landfill;
- all employ widespread separate collection;
- all employ a mix of treatment options but with different profiles:
 - Denmark has the lowest reported landfill rate in Europe and has achieved high diversion rates by maximising energy recovery through incineration while also encouraging separate collection and recovery of specific materials, in particular, paper and garden waste;
 - the Netherlands has achieved high landfill diversion rates with a significant decrease in quantities of BMW landfilled between 1995 (28 %) and 1998 (13 %) mainly through an increased reliance on incineration (26 % in 1995 to 37 % in 1998). The Netherlands also has widespread separate collection and recovery of specific materials, in particular, paper, food and garden waste;
 - the Flemish region of Belgium has seen a significant drop in landfilling of BMW between 1995 (38 %) and 1998 (17 %). However, this has coincided with a decrease in incineration (31 % in 1995 to 22 % in 1998) and an increase in composting (16 % to 34 %) and recycling, mainly of paper (12 % to 23 %).

4.6.1. Denmark

Denmark has a low reliance on landfill and employs a range of treatment options for the management of BMW. In 1998, 5.3 % of BMW was consigned to landfill, 54.3 % to incineration with energy recovery, 29.6 % to composting, 10.4 % to recycling and 0.4 % to anaerobic digestion. The main diversion routes away from landfill are, therefore, incineration with energy recovery, mainly of bagged waste, and composting, mainly of garden waste.

Key strategies and instruments used in Denmark include:

- National policy in relation to the incineration with energy recovery of municipal wastes;
- a waste tax on both landfill and incineration to encourage recycling and recovery;
- a ban on the landfilling of wastes that are suitable for incineration;
- a legal requirement for the collection of newspapers and magazines for recycling; and
- a national policy on increased recycling of BMW.

Waste policy in Denmark is driven by the Danish Waste Model. Its fundamental principle is that coordination of waste management is a public sector task. To support this model, a broad range of instruments are applied. In relation to future planning, the Danish Government's waste management plan 'Waste 21' which addresses the period from 1998 to 2004, includes a description of the Danish strategy on biodegradable waste management. The strategy has two principal aims:

- to promote the separate collection of food waste from households and its treatment in anaerobic digestion plants (i.e. biogas plants); and
- to cease the landfilling of biodegradable waste and waste suitable for incineration ⁽⁶⁾. This waste must either be recycled or incinerated.

These measures will now be described in more detail.

Phase 1 — production

Home composting

In 1998, 179 000 households were served by municipal home composting schemes, with approximately 152 000 households actively participating. A municipal home composting scheme entails the municipality providing containers to households for the purpose of home composting. The containers are either provided free or for a minimal cost. Where home composting is being carried out, a corresponding decrease in the quantity of bagged waste is expected. Where this occurs, a number of the municipalities charge a lower collection fee for household waste. Between 22 200 and 23 700 tonnes of food waste is treated annually by this method. Both the number of households participating in and the number of municipalities running home composting schemes have increased considerably since 1993. In 1993, approximately 58 000 households and 51 municipalities participated in home composting schemes. By 1997, 152 000 households in 86 municipalities were participating in such schemes.

Phase 2 — presentation, collection, transfer and movement

Separate collection

Relatively high separate collection rates exist in Denmark. It is therefore of interest to identify the reasons behind this.

Paper

Since 1990 all municipalities have set up recycling schemes for paper and paperboard generated by the household sector. Today, 39 % of paper from households is collected for recycling.

The statutory order on waste, No 619 of 27 June 2000 stipulates that at least 40 % of each local authority area's household paper and cardboard potential must be collected in 2001. From 2002 and onwards a minimum of 55 % must be collected and recycled. If a local authority is unable to meet these collection targets, or if it does not want to document that it meets them, it must establish kerbside collection schemes with fixed equipment for paper and establish collection schemes for cardboard in areas inhabited by more than 1 000 people. Kerbside collection will entail additional costs of approximately EUR 8.05–13.42 per household, depending on the types of housing and the system chosen.

In general, approximately 50 % of households (information on the breakdown between single and multi-family dwellings are unavailable) are served by a separate collection scheme for paper and paperboard with the remaining 50 % having access to separate collection receptacles at civic waste facilities (recycling centres).

Single-dwelling households are served by either separate collection direct from the house or through delivery of the separated waste to civic waste facilities. In general, for multi-family dwellings, the collection system available consists of separate collection receptacles in close proximity to the dwellings.

In relation to commercial activities, many municipalities require that companies which produce more than for example 50 kg of paper or 50 kg of paperboard a month, are obliged to sort it out for recycling and are obliged to arrange for its collection from their own premises.

(6) The term 'waste suitable for incineration' includes waste with positive heating value e.g., bagged waste, but not waste which according to the Danish waste legislation, is prohibited to incinerate (e.g., PVC), waste which results in environmental problems during incineration and waste as, according to the national or local legislation, that must be separated for recycling or special treatment.

The collection of paper from households will be increased by using more efficient collection systems and collecting more types of paper. In addition, barriers to the recycling of paper, such as the use of glue, will be evaluated (Danish Ministry of Environment and Energy, 1999).

Garden waste

The majority of municipalities have in operation schemes for the separate collection for garden waste even though there is no legal requirement for such waste to be separately collected. Presently, 50 % of households are served by a separate collection scheme for garden waste with the remaining 50 % having access to separate collection receptacles at civic waste facilities (recycling centres). The collection and delivery systems for garden waste for single and multi-dwelling families are similar to those described for paper and paperboard above.

The objective for 2004 is 95 % recycling of garden waste. Anyhow, the amount of separately collected garden waste continues to increase and the former estimates of total amounts are too low. The present efforts will be maintained and no new initiatives are envisaged (Danish Ministry of Environment and Energy, 1999).

Food waste

Municipalities are not obliged to establish separate collection schemes for food waste from the household sector. However, approximately 20 % of the municipalities have set up such schemes which serve about 13 % of the total number of households. Many of these municipalities have chosen to establish home composting schemes instead of separate collection schemes. Food waste is not accepted at civic waste facilities.

The Danish municipalities are required to establish collection systems for food waste from canteens and restaurants that generate greater than 100 kg of food waste per week (7). They are also required to collect the biodegradable fraction arising from supermarkets. This does not form part of the municipal waste.

A collection scheme for the organic fraction arising from supermarkets, bakeries, greengrocer's shops, lunchrooms/canteens in enterprises, national schools, retirement homes etc., is presently being examined (European Commission Environment DG, 1997).

At present 13 % of households are served by separate collection schemes for food waste. The Danish Government aim to increase the quantity of food waste separately collected from private households for subsequent treatment by anaerobic digestion. However, at present the technology is not sufficiently developed to establish a compulsory collection scheme in all municipalities. To promote the development of anaerobic digestion technology the government is providing economic support for the establishment of new plants. Thus the capacity for treatment of food waste from households in anaerobic digestion plants is expected to rise from 20 000 tonnes in 2000 to 70 000–100 000 tonnes in 2004. *Waste 21* specifies a target of 100 000 tonnes of BMW to be treated by anaerobic digestion.

The government's target is to increase the collection and treatment of food waste from households from 51 000 tonnes (1998) to 150 000 tonnes for composting and anaerobic digestion in 2004. Co-treatment of food waste and farm slurry at joint anaerobic digestion plants has first priority for the Danish Government.

Biodegradable waste from canteens and restaurants are presently reprocessed into animal feeds. *Waste 21* recommends that an evaluation be carried out to clarify whether other forms of recycling may be of relevance. Rules for the schemes will therefore be studied and adjusted as necessary.

(7) Statutory Order No 883 of 11 December 1986 on municipal collection of food waste from catering centres.

Phase 3 — treatment*Incineration with energy recovery*

Incineration with energy recovery is the primary treatment route for BMW in Denmark, with 54.3 % of this waste stream incinerated in 1998. Incineration is mainly employed for the treatment of bagged waste.

One of the objectives of the Danish waste management plan is to adjust the capacity of incinerators to actual needs and to locate them in areas where the best possible energy utilisation and largest possible CO₂ mitigation are obtained, taking into consideration principles of regional sufficiency. In recent years, most plants in Denmark have been upgraded for combined heat and power generation, as a number of the incinerators generated heat only. The future aim is to have all incinerators equipped for combined heat and power generation.

Waste taxes

In 1987 Denmark introduced a tax of EUR 5.37/tonne on waste going to landfill and incineration. This was to encourage a shift from landfilling and incineration to recycling. Today, the tax is almost 10 times higher and is differentiated between waste going to landfill (EUR 50.55/tonne) and waste for incineration (EUR 37.58 with combined power and heat generation and EUR 45 with only heat generation). There is no tax on waste for recycling, composting and anaerobic digestion.

The percentage of waste going to landfills has decreased from 39 % in 1985 to 16 % in 1997. The target for 2004 is 12 % to landfill. The largest share of this decrease can be attributed to the recycling of construction and demolition waste (Danish Ministry of Environment and Energy, 1999).

Ban on the landfilling of biodegradable waste

In 1997 the Danish Government introduced a ban on the landfilling of waste suitable for incineration. Thus biodegradable waste which is not treated biologically or otherwise recycled must be incinerated. This regulation has proven to be very successful, having resulted in the diversion of significant quantities of waste away from landfill.

However, at present there is insufficient incineration capacity in Denmark to cope with the expected increase in amounts of waste. As a practical measure to deal with this, when insufficient incinerator capacity exists, biodegradable waste fractions, which degrade the slowest, e.g., wood and plastic, are temporarily packed in plastic bales or placed in designated cells in landfills. When incinerator capacity becomes available, the biodegradable fraction, which was landfilled, has to be dug out and transported to an incinerator for treatment. Incineration capacity is presently being enlarged and is expected to be sufficient in a few years. Bagged or mixed waste is the first priority for incineration. The government's future aim is to shift from incineration to increased recycling and at the same time to shift non-combustible waste directly from landfilling to recycling (Danish Ministry of Environment and Energy, 1999).

Phase 4 — end use/final destination*Compost quality and use*

The general guidelines for use of compost and anaerobic digestate for farming purposes are specified in the Ministry of the Environment and Energy Statutory Order No 49 of 2000. Most compost produced complies with the required standards. The authority generally supervising the quality of compost is the Ministry of Agriculture and Fishery with the 'Plantedirektoratet' controlling the quality of compost by carrying out spot checks.

There are a number of different end-uses for compost in Denmark. Approximately 50 % of the composting plants in Denmark are selling the compost for approx. EUR 8.70/tonne (DKK 65 in 1999). The remainder either give the compost away free of charge or they utilise it within their municipalities. Compost made from pure garden waste often obtains higher prices than compost made from food waste or sewage sludge.

4.6.2. The Netherlands

Although the quantity of household waste increased by 13.4 % between 1995 and 1998 in the Netherlands, the quantities of biodegradable municipal waste being consigned to landfill decreased by more than 50 % over this three-year period. The Netherlands has, for many years, had a low reliance on landfill and employs a range of treatment options for the management of BMW. In 1998, the year for which the most recent data is available, 13.1 % of biodegradable waste from households was consigned to landfill, 36.5 % was consigned to incineration with energy recovery, 33.3 % consigned to composting and 19 % to recycling.

Key strategies and instruments used in the Netherlands include:

- waste prevention and minimisation
- producer responsibility
- high level of separate collection
- ban on the landfilling of biodegradable wastes
- standards for compost quality and use
- landfill and incineration taxes
- other fiscal measures.

Phase 1 — production

Waste prevention

A number of instruments are used in the Netherlands to promote waste prevention, ranging from voluntary to regulatory instruments. Various agreements on prevention have been reached with industry, e.g. an agreement has been reached with the packaging industry to reduce the quantity of packaging brought onto the market (Ministry of Housing, Spatial Planning and the Environment, 1998).

The provision of information is also an important prevention instrument which is used. Publicity campaigns such as 'Less waste is up to you' have been undertaken to encourage the general public to do more to prevent waste from arising in the first instance.

The Association of Dutch Municipalities and the Association of Provinces together with the Ministry of Housing, Spatial Planning and the Environment have prepared a Prevention Implementation Strategy which covers the period 1996–2000. The Strategy aims at encouraging companies to prevent waste arising and focuses on all companies and all types of waste thus including those sectors for which no separate policy had previously been devised. This strategy is implemented through the use of both voluntary and regulatory instruments. Where possible, these are integrated into existing instruments, i.e. permits and target group consultations with industry (Ministry of Housing, Spatial Planning and the Environment, 1998).

Although it is very difficult to measure the effectiveness of waste prevention measures, there has been a stabilisation in the quantity of waste arising in the Netherlands over the last few years despite the growth in the economy, consumption and the number of households. It is considered that the waste prevention measures have contributed to this (Ministry of Housing, Spatial Planning and the Environment, 1998).

Producer responsibility initiatives

These are initiatives or obligations undertaken by those involved in the manufacture, distribution and sale of products. These can be effective tools for making producers take greater responsibility for their end-of-life goods. They can take the form of either voluntary or statutory requirements or a combination of both, e.g. the paper and paperboard industry have reached agreement with the local authorities that all paper and paperboard which is separately collected from households can be handed over at least free of charge. This provides security to local authorities by providing a viable and secure outlet for their collected waste which in turn encourages local authorities to increase the quantity of paper and paperboard which they separately collect. Local authorities have in response to this, committed themselves to collecting 85 % of the eligible paper and paperboard from households.

In addition, the fraction of bulky household waste for which it is possible to attribute to an individual producer, approximately 80 % are covered by systems of producer responsibility that are either presently in operation or are in preparation (Ministry of Housing, Spatial Planning and the Environment, 1998).

Phase 2 — presentation, collection, transfer and movement

Under the Environmental Management Act, 1994, local authorities are required to set up separate collection systems for biodegradable waste from households. Three fractions are separately collected; paper and paperboard, food waste and garden waste.

Paper and paperboard

In April 1995, the Waste Management Council published a programme on 'Separate collection of household waste'. The programme recommended that the most suitable method for collection of paper and paperboard was mono-collection (i.e. collection solely for this fraction) by means of a door-to-door collection service with a frequency of at least once every four weeks. It was estimated that this would result in a collection response of 85 % by the year 2000.

Local authorities are required to collect paper and paperboard separately from households. Also under the terms of the packaging covenant II, the government and industry have agreed that local authorities will be responsible for the collection of paper and paperboard and for financing such collection. However, transportation from the subsequent collection point (e.g., local authority depot) and further treatment will be arranged and financed by the paper and paperboard industry. In the case where the collected material has a market value, the local authorities will be compensated, however, if the collected material has a negative market value, the local authorities will be able to transfer the collected material free of charge. This fraction of paper and paperboard referred to under the packaging covenant also includes non-packaging paper and paperboard.

In 1996, 47 % of the total quantity of paper and paperboard from households was separately collected for recycling. The recycling target for the year 2000 is 85 % (Ministry of Housing, Spatial Planning and the Environment, 1998).

Food and garden waste

The term 'organic waste' is used in the Netherlands to describe the food and garden waste fraction of BMW. This garden waste fraction does not include thick branches. The separate collection of 'organic waste' was introduced in 1992/1993.

As stated above, under the Environmental Management Act, 1994, local authorities are required to collect the biodegradable fraction of household waste separately. However, source separation and separate collection is not compulsory when it is not suitable for technical or economic reasons e.g., for households in old high-rise buildings in city centres (European Commission Environment DG, 1997). Organic waste is collected separately in all municipalities in the Netherlands with approximately 75 % of the population participating in the schemes (Ministry of Housing, Spatial Planning and the Environment, 1998). Local municipal regulations require households to separate both waste streams (European Commission Environment DG, 1997).

Home composting does not form part of the national strategy.

Phase 3 — treatment

Ban on the landfilling of organic wastes

In conformity with the order of preference for waste disposal, the waste (landfill ban) decree came into force in 1995. This decree prohibits the landfilling of waste which can be reused/recycled or incinerated with energy recovery. The decree bans the landfilling of 32 categories of waste coming from both households and companies, with the timing at which the decree comes into force differing per category. Since 1995 the ban has included household waste, paper and paperboard, organic household waste and packaging. Since 1997, the ban has been extended to wood waste. The decree enables the provincial authorities to grant exemption from the landfill ban to operators of landfills, for example, if there is a temporary

shortage of incineration capacity. However, the provincial authority is only allowed to do so if it has obtained a statement from the Environment Minister indicating that at that time in the Netherlands no other processing option other than landfill is available for that particular waste (Ministry of Housing, Spatial Planning and the Environment, 1998).

Importation of combustible waste is permitted into the Netherlands as long as this does not jeopardise the incineration of Dutch waste. Importation of waste for landfill is not permitted (Ministry of Housing, Spatial Planning and the Environment, 1998).

Landfill and incineration taxes

Costs of incineration have been high for the last number of years due to the advanced technology including extensive flue-gas cleaning that is required. Landfill prices have gradually increased through the imposition of a tax. Taxes on the landfilling of reusable or combustible waste are now as high as the highest incineration prices. Exemptions from this tax can only be obtained if there is insufficient incineration capacity available, as discussed above.

These increased costs have had a positive effect on prevention and reuse/recycling. Reuse/recycling has risen dramatically in the past number of years. In 1985 approximately 49 % of total waste arisings were reused/recycled. By 1996 this figure was approximately 73 % (Ministry of Housing, Spatial Planning and the Environment, 1998).

Other fiscal measures

The collection and disposal of the organic fraction of municipal waste is financed through municipal charges on waste put out for collection. Various mechanisms are employed including a tax on refuse bags or taxes based on the size of the household, the size of the container, the frequency of emptying the container or the weight of waste collected per household. Overall, these taxes are resulting in a higher level of source separation of materials for reuse and recovery. However one of the side effects can be the illegal disposal of waste (European Commission Environment DG, 1997).

Phase 4 — end use/final destination

Compost quality and use

The decree governing the quality and use of other organic fertilisers (BOOM) which is part of the fertiliser law, sets standards for the use of compost in addition to sewage sludge and top soil. Compost made from the biodegradable fraction of household waste meets these standards and may be used in specified amounts. In addition to these statutory standards, the industry producing compost from the biodegradable fraction of household waste has drawn up a certificate of its own (Ministry of Housing, Spatial Planning and the Environment, 1998). This certificate covers both process control and final product matters. Over the past number of years the demand for compost made from biodegradable household waste has grown to such an extent that in 1997 demand exceeded supply. This is mainly due to promotional campaigns and other similar activities (Federal Ministry for Environment, Youth and Family Affairs, 1998).

4.6.3. Belgium — Flanders

There is a relatively low reliance on landfill in Flanders where various other management options are utilised. In 1998, BMW was managed in the following manner: 16.7 % landfill; 22.1 % incineration with energy recovery; 34.3 % composting; 22.8 % recycling; 4.1 % reuse. Recent trends indicate a significant increase in the quantity of food and garden waste recovered and a significant decrease in the quantities of BMW incinerated, which makes Flanders an interesting case study.

Key strategies and instruments used in Flanders include:

- ban on landfill of certain separately collected waste streams
- ban on incineration of certain separately collected waste streams
- separate collection schemes
- increasing levels of composting

OVAM, the Flemish Public Waste Office, was established in 1981 as a result of the Waste Decree of the Flemish Government. This Decree is based on the waste hierarchy, with prevention the most desirable option. Since biodegradable waste accounts for about half the total municipal waste produced in Flanders, the policy with respect to the organic fraction is therefore very important in achieving the overall desired result of the waste policy.

The existing policy in relation to this is laid down in the 'Masterplan VFG waste and green-areas maintenance waste'. VFG waste (vegetable, food and garden waste) includes easily degradable fine garden waste materials. Other garden waste from households, along with garden waste from maintenance of public areas, is referred to as 'green waste'. VFG consists of 28 % kitchen waste, 71 % garden waste and 1 % contaminants (some plastics) (European Commission Environment DG, 1997).

The following priorities appear in the Masterplan:

- promotion of prevention (home composting, direct reuse of chips after shredding of garden waste)
- maximisation of the separate collection and treatment of garden waste (called 'green waste' in Flanders)
- maximisation of the separate collection and treatment of VFG waste

Phase 1 — production

Flanders proposes to introduce the 'Diftar' system for the collection of municipal waste. This is operated according to the polluter pays principle. Each waste receptacle will contain an electronic chip, which will contain data in relation to the owner of the waste receptacle. Upon collection the waste receptacle is weighed and the waste produced is quantified in this manner. This system provides an incentive for householders to carry out home composting and to separate other suitable waste at source, prior to collection. As already stated, waste collection charges are higher for collection of mixed waste than for separated waste.

It is also planned to provide demonstration places for home composting. An education programme is planned to encourage people to carry out home composting. In addition to this, there will be an evaluation of existing systems with the aim of improving the quality of separately collected waste.

Phase 2 — presentation, collection, transfer & movement

Separate collection

Flanders achieves a high rate of separately collected BMW. In 1998, 68.8 % of total BMW was separately collected. More than half of this was accounted for by separately collected food and garden waste. Participation in separate collection of food waste is 57 % and for garden waste is 96 %. Cost for collecting unsorted household waste is greater than cost for separate collection so there is an incentive to separate suitable wastes at source.

Food Waste (called 'Biowaste' in Flanders)

The Biowaste and Vegetational Waste Execution Plan was published in 1995. In 1997, approximately 2.7 million people were served by separate collection of food waste (i.e. VFG waste as previously described). This refers to the biodegradable fraction of household waste and is collected in different size receptacles, usually every two weeks. Receptacles may be biobins or biodegradable plastic bags. In 1998, separately collected food and garden waste accounted for 37.5 % of total BMW produced and 56.1 % of the total quantity of BMW separately collected.

Garden waste (called 'vegetational' waste in Flanders)

The execution plan stated that by the end of 1997, each inhabitant of Flanders would have access to separate collection of garden waste. By the end of 1997, separate collection of garden waste (biodegradable waste generated by gardening and maintenance activities in public and private gardens and parks) was available to about 5.8 million people. The quantity of this waste arising from professional gardeners in 1997 was estimated to be less than 10 000 tonnes. Garden waste is either collected by the kerbside method, usually presented in bulk, or by means of the bring method. However, some regions also offer biodegradable plastic or

paper bags for the collection of garden waste, with or without an additional charge. In such cases, the collection frequency is generally higher than for collection in bulk. In some cases, there is door-to-door shredding of garden waste so that the producer can re-use the chips.

Paper and paperboard

The next greatest quantity of separately collected BMW is paper and paperboard, accounting for 30 % of the total amount of separately collected BMW and 20.1 % of the total quantity of BMW produced. Separate collection of this waste stream was introduced between 1991 and 1995. This is achieved through door-to-door collection at least once every month, and a cardboard box receptacle is used. Paper and paperboard may also be delivered to container parks. In 1998, there was 100 % participation in separate collection of paper and paperboard in Flanders.

Others

Separate collection services are also provided for textiles and wood. Textiles account for 1 % of total BMW produced and 1.4 % of the total quantity of BMW separately collected. Wood accounts for 3 % of total BMW and 4.5 % of the total amount of separately collected BMW.

Phase 3 — treatment

Increased levels of composting

There was a significant increase in the quantity of BMW composted from 16.3 % in 1995 to 34.3 % in 1998. Garden and park waste is composted centrally in the open air while VFG waste is mainly composted at central in-vessel composting plants. Home composting reduces collection costs for households. Composting bins for home composting are subsidised by the government. The aim is to have qualified composting experts in as many municipalities as possible, in order to provide support to those households where home composting is being carried out.

Incineration bans

There is a ban on the incineration of certain biodegradable wastes in Flanders. Since 1 July 1998, the incineration of separately collected food and garden waste and separately collected paper and paperboard waste has been banned. Since 1 July 2000, this ban has extended also to non-sorted municipal waste. However, in 1998, incineration with energy recovery still accounted for 22.1 % of the total quantity of BMW produced in Flanders. The majority of this quantity was accounted for by biodegradable municipal waste collected as bagged waste. There is a distinct shift away from incineration of BMW in Flanders, decreasing from 31.2 % of total BMW produced in 1995 to 22.1 % of total BMW in 1998.

Waste taxes

In 1998, the following taxes applied to incineration of municipal waste in Flanders: EUR 6/tonne if energy recovery takes place and 13 EURO/tonne if there is no energy recovery. In relation to landfilling of municipal waste in 1998, a tax of EUR 55/tonne normally applied. However, if energy regeneration takes place as a result of the collection and utilisation of landfill gases, the tax on landfilling is reduced to EUR 52/tonne. As can be seen, tax on waste going to landfill remains significantly higher than the tax on waste going to incineration. As a result of these waste taxes, there was a considerable reduction in the quantity of BMW landfilled and incinerated between 1995 and 1998.

Ban on the landfilling of biodegradable waste

There is a policy of banning the landfilling of certain biodegradable wastes. Since 1 July 1998 separately collected paper and paperboard waste, separately collected food and garden waste and municipal waste from households has been banned from all landfills in Flanders. The quantity of BMW being landfilled decreased from 37.3 % of the total quantity of BMW produced in 1995 to 16.7 % in 1998.

Phase 4 — end use/final destination

Compost quality and use

The trading in fertilisers and soil improving agents is regulated by the Royal Decree (Koninklijk Besluit) of 1977 which was amended in 1986 and again in 1990. Compost made from VFG waste and garden waste is not specified by this legislation. However, the 'Inspection

of raw materials' branch of the Ministry of Agriculture is able to issue temporary permits to use fertilising and soil improving agents which are not defined in this Royal Decree. Such permits have been granted for compost made from VFG waste and from garden waste once it complies with specified standards (European Commission Environment DG, 1997).

In 1992 the Public Waste Company for Flanders (OVAM) set up the Flemish organisation VLACO for promotion of the above type of compost. VLACO is a cooperation between OVAM, communities, private compost producers, some cities and compost distributors and producers of growing media/soil conditioning products. The major tasks of VLACO are compost marketing, compost quality control and research (Federal Ministry for Environment, Youth and Family Affairs, 1998). Compost which meets the quality standards of VLACO, which are stricter compared to those of the Ministry of Agriculture and which is produced in accordance with an integrated process control can get the VLACO quality label. This quality system was set up by VLACO to promote the sale and application of this type of compost. The quality standards of VLACO are in accordance with the Dutch standards for this type of compost which is regulated in the decree on other organic fertilisers (BOOM) and the German standards as specified by the Federal Compost Association (Bundesgutegemeinschaft Kompost). In addition, the quality parameters are required to be analysed by the standard methods specified by the Ministry of Agriculture both during and after the composting process (European Commission Environment DG, 1997).

There are numerous end-markets for compost produced in Flanders. In 1997, 30 % was sold for use in landscaping, 18 % for private use, 15 % as potting soil, 11 % to soil mixing companies, 8 % to other wholesalers, 6 % to horticulture, 5 % for agriculture, 3 % for soil sanitation and the remaining 4 % was exported mainly to the north of France where it was used in vineyards (European Commission Environment DG, 1997).

4.7. Conclusions

It is clear for the three case studies presented that a suite of strategies and instruments were successfully used to achieve the twin objectives of better BMW management, i.e.

1. High rates of diversion of BMW away from landfill
2. High rates of recovery, in particular, material recovery, of BMW diverted away from landfill.

Countries that have made significant strides towards achieving these objectives have certain things in common. In particular, there is significant state intervention in all cases to encourage, on the one hand, high levels of separate collection and, on the other hand, high levels of diversion away from landfill, and in some cases, diversion away from incineration as well. This intervention mainly consists of legal requirements for separate collection of specific waste streams and taxes and restrictions on the landfilling and incineration of specific waste streams.

The net effect of encouraging separate collection and restricting disposal outlets is that:

- the quantity of material available for recovery is maximised, and
- the available routes for disposal of materials are curtailed.

This is clearly illustrated by the case studies presented above. In all three cases, the countries and regions involved have high levels of separate collection leading to relatively large quantities of waste destined for recovery. Recovery routes vary from one country to another with an interesting contrast to be seen between Denmark, with its high dependence on incineration with energy recovery and Flanders, where incineration of municipal waste is essentially being phased out. To a large extent, local conditions and markets will determine the most appropriate mix of options for a particular country and region. For instance, incineration of municipal waste is an important element of general energy policy in Denmark, where many district heating schemes are in existence, and thermal treatment is therefore likely to continue as a key component of the BMW management strategy.

The risks involved in pursuing a strategy of large-scale separate collection and tight restrictions on disposal are also worth considering. First of all, if adequate and reliable outlets are not available for the materials being separately collected, countries and regions investing heavily in separate collection risk the creation of a separate waste management problem. This means that the question of adequate and reliable outlets for compost and paper, in particular, needs to be fully addressed, preferably before large-scale separate collection systems are put in place. At the very least, integrated plans are required at both local and national level to ensure that there is linkage between collection of waste materials from households and business premises, the processing and quality of these materials and the subsequent use of end-products such as compost or recycled fibre.

The other risk attached to the strategy is an increase in illegal dumping of waste by waste producers and waste handlers looking for ways to avoid paying higher costs associated with such a strategy. However, the possibility of illegal activity should not be allowed to impair the implementation of measures to meet the targets set by the landfill directive. It could also be argued that one of the best defences against illegal dumping is the provision of an adequate network of facilities in advance of imposing legal restrictions on disposal. This means, for instance, that where countries are planning to introduce bans or restrictions on the landfilling or incineration of specific parts of the BMW waste stream, sufficient time should be allowed and resources invested to ensure that alternative arrangements are in place for the waste to be diverted away from disposal.

5. Key issues and proposed indicators

The key issues identified in relation to meeting the targets set out by the landfill directive are discussed below, along with conclusions where they arise. A set of indicators has also been developed which are presented below (Table 12).

5.1. Identification of key issues

Key issues identified at the start of this project were:

- available options for diversion of biodegradable waste away from landfill;
- available options for separate collection of biodegradable waste;
- appraisal of treatment options used to date, including composting, anaerobic digestion, and incineration;
- impact of diversion of biodegradable waste away from landfills;
- environmental consequences of choosing particular diversion options such as composting, anaerobic digestion and incineration;
- quality and market issues for products such as compost from biodegradable waste;
- standards for products produced from the recovered waste;
- fiscal instruments including landfill and other taxes; and
- definition of indicators for biodegradable waste suitable for national and EEA indicator-based reporting.

In preparing this project, some key issues of particular importance have been identified which require consideration when planning for compliance with the targets set by the landfill directive for diversion of BMW away from landfill. These are:

The need for good quality and consistent information

A standard approach to tracking progress towards the landfill directive targets is needed. A standard approach to tracking BMW flow in individual countries would also be a useful tool to measure progress towards the achievement of the targets.

However, based on the information supplied by EEA member countries during the course of this project, there are considerable gaps in information at national level. Many countries had difficulty describing the flow of BMW in their jurisdictions. Reliable waste flow information is an essential building block of any national strategy and ongoing efforts are therefore required to establish harmonised systems of data collection and reporting. It is rather alarming that the relatively simple formats for reporting summary information on BMW production and management provided such difficulty for so many countries, mainly due to an absence of basic information at national level.

A problem also exists in relation to the definition of biodegradable municipal waste that results from the well-documented difficulties that exist in relation to the definition of municipal waste. It is worth repeating the earlier conclusion, in relation to this matter, that the definition provided in the landfill directive was the most practical from the point of view of comparing one country to another since it simply defines municipal waste as household-type waste from any source.

The operational definition provided in sub-section 2.1 of this report is recommended for the purpose of gathering data on biodegradable municipal waste, and it follows on from the approach to investigate the comparability of household and municipal waste. There is, however, **a requirement for more detailed descriptions of the actual waste types to be considered as well as guidelines on how to establish the composition of the bagged (mixed) waste component.**

Integrated approach to developing national strategies

The experience of countries and regions that have succeeded in diverting large quantities of BMW away from landfill strongly suggests that an integrated package of options is needed at national level to achieve high diversion rates. Countries with high rates of diversion of BMW away from landfill employ a combination of separate collection, thermal treatment, centralised composting and material recycling. Thermal treatment, mainly incineration, is generally used for the treatment of bagged waste while composting, re-use and recycling are employed for separately collected wastes such as paper and cardboard, garden wastes, textiles, wood and, to a lesser extent, food wastes. Technologies such as anaerobic digestion, gasification and pyrolysis are in use to a lesser extent, although as the technologies develop their use could become more widespread.

Therefore **countries should identify a range of options for managing BMW away from landfill. These options should be linked clearly to available markets and outlets for materials diverted away from landfill.** This will require the development of plans for the management of both the mixed waste stream and specific materials separated from the waste stream, in particular food waste, garden waste and paper/cardboard waste. Countries that currently collect the bulk of BMW as part of the mixed waste stream clearly need to plan for both radical reductions in the quantity of mixed waste collected and radical increases in the separate collection of specific materials.

Collection systems

All countries and regions surveyed employ a mix of traditional 'bagged waste' collection and separate collection. Generally, traditional 'bagged waste' is either landfilled or incinerated, although some non-thermal treatment also occurs, such as central composting for mass reduction only. The key to achieving both high landfill diversion rates and high re-use, recycling and composting rates (i.e. recovery other than energy recovery) appears to be the provision of widespread separate collection facilities, together with the availability of adequate capacity and markets for the materials thus collected.

Source separation and separate collection should therefore be considered for inclusion in national strategies for meeting the targets set by the landfill directive

This suggestion comes with a note of caution. Each country will need to work out a realistic and achievable target for source separation and separate collection so that it is reasonably confident that the quality of the recovered materials are sufficiently high and that viable markets and outlets exist.

Treatment options

At present, there appears to be a relatively small number of proven treatment options available for BMW diverted away from landfill. The three principal alternatives in use at present are **incineration with energy recovery**, mainly of bagged waste, **central composting**, mainly of garden wastes (and, to a lesser extent, food wastes) and **material recycling**, mainly for paper and cardboard wastes. Some other routes are in use such as anaerobic digestion and use of food waste as animal fodder, but generally, for relatively small quantities of waste. More recent or emerging technologies such as gasification and thermolysis may also play a role in national strategies for the management of BMW.

Availability of markets and other outlets for compost and other end products

As stated earlier in this report, if adequate and reliable outlets are not available for materials being separately collected, countries and regions investing heavily in separate collection risk the creation of a separate waste management problem. **National planners should be fully aware of the importance of establishing and maintaining adequate markets and outlets when drawing up national strategies and plans for the diversion of BMW away from landfill.**

Bans and restrictions on landfilling/disposal taxes

A key instrument available to individual countries is to impose bans or restrictions on the landfilling of specific waste streams or to tax disposal in order to make recovery a more economically viable option. Perhaps the optimum approach is **to have a combination of progressive restrictions on acceptance of specific waste streams at landfill together with a**

taxation system that increases the cost of landfilling to a point where it is no longer a financially attractive option. However, whatever approach a country chooses to take, it is essential that alternative routes be identified in advance for waste diverted away from landfill.

Monitoring national strategies for BMW

The landfill directive sets out clear targets and a clear timeframe for reducing the absolute quantity of BMW being consigned to landfill. By basing the target on 1995 production data, a clear roadmap is available for each country, provided that reliable data or, at least, agreed data, is available for BMW production in 1995, in accordance with the requirements of the Directive. This roadmap is illustrated for each country in the BMW management sheets, which can be downloaded from www.eea.eu.int. The net impact of future growth in BMW production, were this to happen, is that larger quantities of BMW will require treatment by routes other than landfill. It is therefore essential that, as part of its national strategy, **each country sets up a monitoring and management system that will allow it to track BMW production and management on a continuous basis.** Such a system would make the link between production of BMW, its subsequent management and the final destination or use of materials, such as compost, produced through its management. Monitoring should be conducted on a continuous basis so that instruments and strategies in use to divert BMW away from landfill are regularly audited and checked for their relative effectiveness and remedial action taken where necessary.

5.2. Proposed indicators

The following is a list of indicators that are considered useful in tracking progress towards the targets and objectives set by the landfill directive (priority indicators are highlighted in bold). An overview of these priority indicators is presented in Table 12 for countries where data was available.

Directive target

Quantity of BMW landfilled as a percentage of BMW produced in 1995

Production of BMW

Quantity of BMW produced per annum

The ratio of BMW to MW

Per capita production of BMW (tonnes/annum)

Collection of BMW

% of BMW separately collected

% of BMW collected as bagged waste

Treatment of BMW

% of BMW produced that is landfilled (each year)

% of BMW produced that is subjected to thermal treatment (each year)

% of BMW incinerated with energy recovery

% of BMW incinerated without energy recovery

% of BMW subjected to other thermal treatments

% of BMW produced that is recovered by means other than incineration with energy recovery

% of BMW composted

% of BMW anaerobically digested

% of BMW recycled

% of BMW re-used

Use of products produced from BMW

% of compost produced that was put to beneficial use

Proposal of priority indicators for tracking BMW management

Table 12

Country or region	Production indicator	Landfill directive target indicator ¹⁾		Collection indicators		Treatment indicators ²⁾			Year ³⁾
	BMW production/capita ⁴⁾ (tonnes/person/annum)	1995	Latest year	% of BMW collected as bagged waste	% of BMW collected in separate fractions	% of BMW being consigned to landfill	% of BMW being consigned to Incineration	% of BMW being consigned to other recovery processes	
Austria	0.19	20.2	21.5	43.0	57.0	20.4	13.3	58.5	1996
Denmark	0.35	11.3	5.8	58.0	42.0	5.3	54.3	40.5	1998
Belgium (Flanders)	0.28	37.3	3.9	32.2	68.8	16.7	22.1	57.1	1998
Finland	0.33 (1994)	65.2	64.9	70.0	29.3	64.9	5.8	28.6	1997
France	0.27	38.0	42.8	81.8	18.2	40.3	35.7	12.7	1998
Germany	0.35 (1993)	70.2 ⁵⁾	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Baden-Württemberg	0.57	42.7	29.1	62.0	38.0	30.2	12.3	55.0	1998
Greece	0.25 (1997)	100	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Iceland	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Ireland	0.27	91.2	106.0	90.0	10.0	90.3	0	9.8	1998
Italy	0.16 (1996)	74.4	71.8	85.7	14.3	68.4	5.7	19.5	1997
Luxembourg	N/A	21.3	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Netherlands ⁶⁾	0.31	28.3	14.5	47.7	52.3	13.1	36.5	52.3	1998
Norway	0.36	68.0	58.2	68.7	31.3	59.0	17.0	25.0	1997
Portugal	N/A	100	N/A	N/A	N/A	N/A	N/A	N/A	N/A
UK (England and Wales)	0.32	89.5	93	72.1	27.9	86.2	5.7	8.1	1998/ 99
Spain	0.31 (1996)	75.8	N/A	N/A	N/A	N/A	N/A	N/A	N/A
Catalonia	0.32	74.6	77.4	95.0	5.0	73.4	20.7	5.9	1998
Sweden	N/A	36.0	N/A	N/A	N/A	N/A	N/A	N/A	N/A

1) Quantity of BMW landfilled is stated year as a percentage of BMW produced in 1995.

2) Treatment may not, in all cases, add up to 100 %, due to imbalance between reported production and reported treatment.

3) Relevant year for landfill directive Target Indicator (latest year), collection indicators and treatment indicators.

4) Refers to data for 1995 unless otherwise stated.

5) This figure is derived from the Eurostat baseline for production and landfilling of BMW.

6) Refers to waste from households only.

N/A: No information available

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