Technical report for

End-of-waste criteria on

Biodegradable waste subject to biological treatment

Second Working Document

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Institute for Prospective Technological Studies

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1 Introduction

1.1 Background

The Waste Framework Directive (2008/98/EC, in the following referred to as 'the Directive' or WFD) among other amendments introduces a new procedure for defining end-of-waste (EoW) criteria, which are criteria that a given waste stream has to fulfil in order to cease to be waste.

Waste streams that are candidates for this procedure must have undergone a recovery operation, and comply with a set of specific criteria. These criteria are yet to be defined for each specific waste stream, but the general conditions that a waste material has to follow are defined by Article 6 of the WFD in the following terms:

'certain specified waste shall cease to be waste [within the meaning of point (1) of Article 3] when it has undergone a recovery, including recycling, operation and complies with specific criteria to be developed in accordance with the following conditions:

a) The substance or object is commonly used for a specific purpose;
b) A market or demand exists for such a substance or object;
c) The substance or object fulfils the technical requirements for the specific purpose referred to in (a) and meets the existing legislation and standards applicable to products; and
d) The use of the substance or object will not lead to overall adverse environmental or human health impacts.'

Moreover, Articles 6(2) and 39(2) of the Directive specify the political process of decision-making for the criteria on each end-of-waste stream, which in this case is a Comitology procedure[1] with Council and Parliament scrutiny, the output taking the form of a Regulation. As input to decision-making in Comitology, the European Commission is to prepare proposals for end-of-waste criteria for a number of specific waste streams, including biodegradable waste.

A methodology guideline[2] to develop end-of-waste criteria has been elaborated by the Joint Research Centre's Institute for Prospective Technological Studies (JRC-IPTS) as part of the so-called 'End-of-Waste Criteria report'. The European Commission is now working on preparing proposals for end-of-waste criteria for specific waste streams according to the legal conditions and following the JRC methodology guidelines. As part of this work, and for each candidate waste stream, the IPTS will prepare studies with technical information that will support each of the proposals for end-of-waste criteria. Besides describing the criteria, these studies will include all the background information necessary for ensuring conformity with the conditions of Article 6 of the Directive.

For each waste stream, the background studies will be developed based on the contributions of experts from Member States and from interested stakeholders, by means of a technical working group. The working groups are composed of experts from Member States administration, industry, NGOs and academia. Experts of these groups are expected to

(1) The progress of the Comitology processes on the WFD can be followed at: http://ec.europa.eu/transparency/regcomitology/index_en.htm
(2) End-of-waste documents from the JRC-IPTS are available from http://susproc.jrc.ec.europa.eu/activities/waste/. See in particular the operational procedure guidelines of Figure 5 in the "End-of-Waste Criteria" report.

contribute with data, information or comments to written documents and through participation in expert workshops organised by the IPTS. Individual experts may be asked to assist to the workshops on a case by case basis.

The communication procedure is as follows: for each waste stream IPTS takes initiative and submits background documents with questions to the technical working group. Open questions are discussed with the experts at the workshops, and if needed to clarify individual elements, by personal communication. IPTS collects the necessary information from the experts, as appropriate before and/or and after the workshops, and synthesises this information in draft documents. At the end of the process for each waste stream, these documents result in technical proposals on end-of-waste, and are submitted to DG Environment for further use in the preparation of proposals of Commission Regulations.

In the political decision process, Member States (Comitology in the Technical Adaptation Committee under the Waste Framework Directive, followed by scrutiny from both Parliament and Council) will discuss each of the Regulation proposals and if approved, these will enter into force.

1.2 Objectives

This background paper has been prepared as input to the second expert workshop on biodegradable waste subject to biological treatment, to be held at IPTS, Seville, on 24-25 October 2011. As such, this study presents a picture of the possibilities for recovering biodegradable waste, including the areas of information that need to be documented for defining end-of-waste criteria. Selected items of this study will be discussed with experts during the second workshop.

The ultimate objective of this study is to provide the full background information for use in the technical proposal on end-of-waste for biodegradable waste. A final draft version of this document will be distributed for consultation following the second workshop, prior to establishing the final version.

1.3 Scope definition

Terminology

According to the Commission Staff working document[3] accompanying the Communication from the Commission on future steps in bio-waste management in the European Union[4], there are different categories of waste suited for some form of biological treatment:

"Bio-waste" is defined in the Waste Framework Directive (WFD) as "*biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises, and comparable waste from food processing plants*". It does not include forestry or agricultural residues, manure, sewage sludge, or other biodegradable waste (natural textiles, paper or processed wood).

([3]) http://ec.europa.eu/environment/waste/compost/pdf/sec_biowaste.pdf
([4]) http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=COM:2010:0235:FIN:EN:PDF

"Biodegradable waste" is a broader concept defined in the Landfill Directive as any waste that is capable of undergoing anaerobic or aerobic decomposition, such as food and garden waste, and paper and paperboard.

The total yearly production of bio-waste in the EU amounts to 118 to 138 Mt of which around 88 Mt originate from municipal waste and between 30 to 50 Mt from industrial sources such as food processing[5]. In the EU, bio-waste usually constitutes between 30% and 40% - but can range from 18% up to 60% - of municipal solid waste (MSW). The bio-waste part of MSW comprises two major streams: green waste from parks, gardens etc. and kitchen waste. The former usually includes 50-60% water and more wood (lignocellulose), the latter contains no wood and up to 80% water.

In its Communication on future steps in bio-waste management in the EU, the Commission states that compost and digestate from bio-waste are under-used materials. Furthermore, it is mentioned that the End of Waste procedure under the Waste Framework Directive could be the most efficient way of setting standards for compost and digestate that enable their free circulation on the internal market and to allow using them without further monitoring and control of the soils on which they are used. In this respect, the current work's scope is limited to compost and digestate. Compost and digestate are defined in this study as follows:

- ***Compost***: compost is the solid particulate material that is the result of composting and which has been sanitised and stabilised. Composting is a process of controlled decomposition of biodegradable materials under managed conditions, which are predominantly aerobic and which allow the development of temperatures suitable for thermophilic bacteria as a result of biologically produced heat.

- ***Digestate***: digestate is the semisolid or liquid product of anaerobic digestion of biodegradable materials. It can be presented as whole digestate or separated in a liquor phase and a fibrous semisolid phase. Anaerobic digestion is a process of controlled decomposition of biodegradable materials under managed conditions, predominantly anaerobic and at temperatures suitable for mesophilic or thermophilic bacteria.

Furthermore, the study is restricted to materials derived from a waste treatment operation consisting of composting or anaerobic digestion of biodegradable materials.

Moreover, the current study envisages *recycling* of the material derived from composting or digestion of biodegradable waste, rather than energy recovery. It is noted that the JRC IPTS is currently also coordinating a study on the feasibility of End of Waste criteria for a variety of candidate waste derived fuels, including biodegradable wastes.

Finally, biodegradable *materials that have not been subject to composting or anaerobic digestion* are explicitly excluded from this study, such as raw sewage sludge or residues of crops that are ploughed in on farmland or textiles that are being reused.

Annex E lists a number of streams that were suggested as potential candidates for End of Waste status during the stakeholder survey, but are not eligible due to clear deficiencies with

([5]) Data based on data on municipal waste from EUROSTAT, source : Arcadis/Eunomia report 2009 regard to one or more conditions for End of Waste status set out in the Waste Framework Directive.

1.4 Structure of this document

As a general remark, it should be pointed out that this document is partially based on information provided in the case-study on compost presented in Chapter 2 of the final report on End-of-Waste Criteria([6]). It has been complemented with data from new research and input provided by stakeholders during and following the first workshop held in Seville on 2 March 2011, especially for the items dealing with digestate.

This document consists of tree differentiated main chapters, which follow the lower part of the conceptual illustration in Figure 1. The first part of the study (Chapter 2) corresponds to the second row of Figure 1 and presents an overview of compost and digestate, its composition, the types and sources of compost and digestate, its processing, grading and recycling. The chapter contains information on the fulfilment of the four conditions set out in Art. 6 of the Directive, namely the existence of a market demand and a specific use for compost and digestate, the identification of health and environmental impacts that may result from a change of status, the conditions for conformity with standards and quality requirements, and the legislative framework of compost and digestate inside and outside waste legislation.

The second part of the study (Chapter 3), describes the results of a sampling and analysis campaign organised by the JRC on inorganic and organic pollutants of a series of compost and digestate samples that were initial candidates for receiving end-of-waste status. This campaign has been established following discussions held during the first workshop (March 2011) that revealed the need to obtain recent scientific data allowing comparative analysis, in order to judge the suitability of different materials. It was understood that these necessary scientific data could only be generated through a pan-European collaborative screening exercise, consisting of measuring a large series of biodegradable waste samples in the best possible standardized way. The campaign was organized in May-September 2011.

The third part of the study (Chapter 4), referring to the bottom row in Figure 1, gravitates on a proposal of a set of EoW criteria, and includes the main conclusions of the discussions and consultations held with the expert group during and following the first workshop held in Seville (2 March 2011).

([6]) Eur 23990 EN-2009

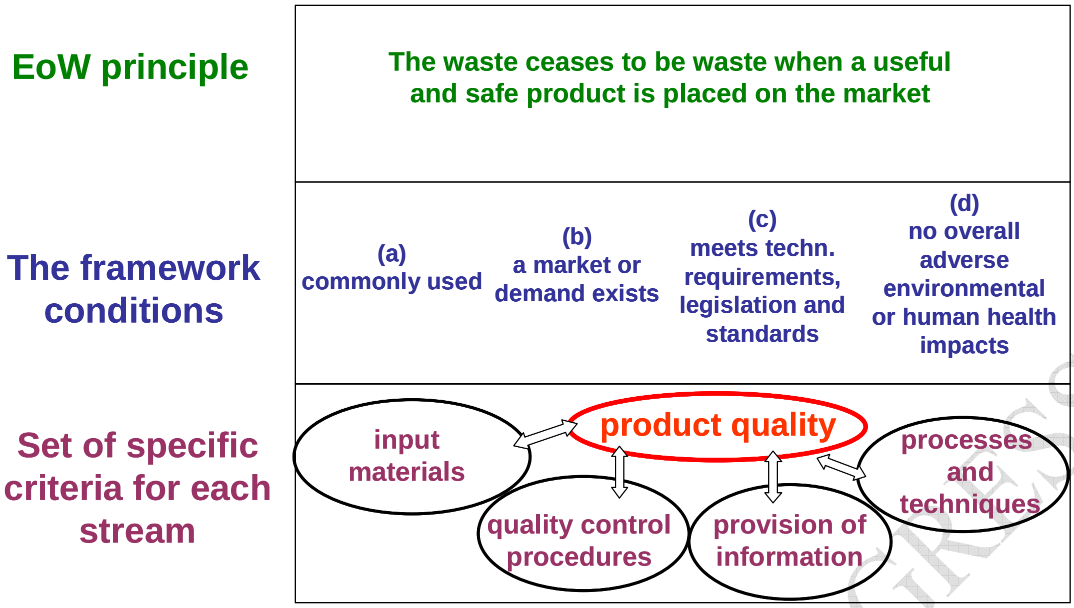

Figure 1. Conceptual illustration of the principle, framework conditions and elements of EoW criteria.

Chapter 5 describes the identified potential impacts of the implementation of end-of-waste criteria.

2 Background information on compost and digestate

2.1 Types of biodegradable waste

Biodegradable fractions of municipal solid waste (MSW)

MSW comprises wastes from private households and similar wastes from other establishments that municipalities collect together with household waste. While the exact composition of MSW varies considerably from municipality to municipality and across Member States, it always contains an important portion of biological material. Depending on the country, kitchen waste and 'green' waste from gardens and parks make up 30–50 % of the total mass of MSW. Together they are sometimes called putrescible wastes or 'biowastes'. The term 'biowaste', however, is not always used in the same way and sometimes refers to kitchen waste only and excludes green waste ([7]). Kitchen waste consists largely of food waste. On average, the amounts of kitchen and green wastes are about the same but there are important local variations, for instance, between rural and urban areas. Also the paper fraction in MSW consists, to a large degree, of processed biological material, and so does a part of the textile waste (from non-synthetic fibres).

Other biodegradable wastes

Other biodegradable wastes that may be composted on their own or together with the biodegradable fraction of MSW include mainly the following items:

- commercial food waste, not collected as part of the MSW, including:
    - waste from markets
    - catering waste;

- forestry residues, including:
    - bark
    - wood residues;

- waste from agriculture, including:
    - animal husbandry excrements (solid and liquid manure)
    - straw residues
    - sugar beet and potato haulm
    - residues of growing of beans, peas, flax and vegetables
    - spent mushroom compost

- wastes from the food and beverage industry, including:
    - breweries and malt houses
    - wineries
    - fruit and vegetable production industry
    - potato industry including starch

([7]) In the Waste Framework Directive, bio-waste is defined as biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises and comparable waste from food processing plants

- sugar beet residues and soils
- slaughterhouse residues
- meat production
- whey;

- sewage sludge (derived from biological treatment of wastewater)

Practically all biological wastes are biodegradable in the presence of oxygen (aerobic conditions) and most biological materials are biodegradable also without oxygen (anaerobic conditions). A relevant exception is lignin (in woody materials) which does not degrade anaerobically. The speed of the degradation depends on the environment in which it takes place. Moisture, temperature, pH and the physical structure of the materials are some of the key parameters. Burning or incineration is the other main option for decomposing biological material.

2.2 Treatment options

Biodegradable wastes can undergo a series of treatment operations. The major processes are listed below. Frequently, combinations of the listed treatment options are implemented as well. The current section does not consider treatment options for which biowaste should legally be considered as a by-product, such as the processing into animal feed.

Landfill

In the past, landfilling mixed MSW without pretreatment or separating out the biological fraction was common practice in most Member States. This option is today considered bad practice because it is associated with environmental and safety risks related to a.o. landfill gas with a high greenhouse gas potential (methane), leachate and space usage.

Through the Landfill Directive ([8]), the European Union has laid down strict requirements for landfills to prevent and reduce the negative effects on the environment as far as possible. Amongst other things, the Landfill Directive requires that waste must be treated before being landfilled and that the biodegradable waste going to landfills must be reduced gradually to 35 % of the levels of the total amount of biodegradable municipal waste produced in 1995.

Incineration and other thermal treatments

The combustion of waste in incinerators allows diminution of the waste for material recovery (e.g. metals) or disposal in landfills to an inert inorganic ash residue. The organic carbon and hydrogen are oxidised to CO_2 and H_2O which are discharged to the atmosphere in the flue gas.

Large-scale mass burn incineration is the most common form of incineration today. It means that waste is combusted with little or no sorting or other pretreatment. However, due to the low calorific value and high water content of many biodegradable wastes (with the exception of paper and wood), exclusion of biodegradable materials by source separation is generally preferred for incineration. In most present-day incinerators, the energy is recovered to produce

([8]) Council Directive 1999/31/EC of 26 April 1999 on the landfill of waste (OJ L 182, 16.7.1999, p. 1).

electricity and/or heat. The calorific values of individual types of waste vary considerably, from about 4 GJ/tonne for food waste to over 35 GJ/tonne for some plastics (Smith et al., 2001). Waste is generally blended to reach an average of 9-12 GJ/tonne so that combustion occurs without pilot fuels, as their use is discouraged by the R1 formula.

An alternative option to mass burn incineration is to preprocess the waste to produce refuse derived fuels (RDF). Processing the waste allows the removal of several streams of recyclable materials, including biodegradable wastes, which receive separate treatment. The combustible residue has a higher calorific value than mixed waste, and may then be burned directly or co-incinerated, for example in cement kilns.

Newly emerging technologies involve pyrolysis and gasification to first break down the organic matter in the waste into a mixture of gaseous and/or liquid products that are then used as secondary fuels. However, these technologies are still in a development stage.

The Waste Incineration Directive from 2000([9]), which will be repealed with effect from 7 January 2014 and has been merged into the Industrial Emissions Directive([10]), aims to prevent or to reduce negative effects on the environment caused by the incineration and co-incineration of waste. In particular, the conditions laid down in the directive should reduce pollution caused by emissions into the air, soil, surface water and groundwater, and thus lessen the risks which these pose to human health. This is to be achieved through the application of operational conditions, technical requirements, and emission limit values for waste incineration and co-incineration plants within the Community.

<u>Mechanical biological treatment (MBT)</u>

In mechanical biological treatment, the mixed MSW undergoes a mechanical sorting of the waste into a biodegradable fraction and a reject fraction, which may be further split, especially to sort out and recycle metals. The remainder of the reject fraction is either landfilled or incinerated.

The biodegradable fraction is then composted or aerobically digested, according to the methods described below. By composting and digestion, the volume of the material and its further degradability are reduced (stabilisation). It is important to note that, depending on the final purpose of the organic fraction, MBT installations are designed differently. Mechanical biological treatment either aims

- at a landfillable fraction with a minimum of unstable organic material

or

- at a stabilized organic fraction that can be recycled in e.g. agriculture with an acceptable maximum level of impurities (only allowed in certain Member States)

The latter technology is also called Mixed Waste Composting.

When landfilled, the stabilised residual waste has a much reduced capacity for producing landfill gas and leachate, and it can provide a very compact material. It can also be used to

([9]) Directive 2000/76/EC of the European Parliament and of the Council of 4 December 2000 on the incineration of waste (OJ L 332, 28.12.2000, p. 91).

([10]) Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (OJ L 334, 17.12.2010, p. 17) cover or restore land on landfills. When used in agriculture or horticulture, quality demands are higher and the material needs to respect several limit values on pollutants.

Composting

Composting is the aerobic degradation of waste to produce compost. It has a long history in many parts of Europe. Originally it was used in the form of simple processes on a small scale for farm and back yard composting. In the last two decades, composting has received renewed and widened interest as a means of addressing current waste management challenges, in particular for reducing the amount of wastes going to landfills and the associated CH_4 emissions from the degradation of organic materials in landfills. The production of compost is also seen as an opportunity for providing a material that can be used as a component in growing media or as an organic fertiliser or soil improver. These and other uses of compost are discussed in more detail in Section 2.4 below.

Many installations producing composts for use as growing media or soil improvers rely on source-separated biological fractions of MSW (kitchen waste and/or garden and park waste). The rationale for this is to keep the levels of compost contamination with undesirable materials, such as glass or plastic, and other substances, such as heavy metals and organic pollutants, as low as possible. Recently, technologies have been under development with the aim of achieving high compost purities from the organic fraction of mixed MSW by means of enhanced material separation before and throughout the composting process. The other main types of compost are compost produced from bark, manure and from sewage sludge (together with bulking material).

The size of composting plants ranges from treatment capacities of less than 1 000 tonnes to more than 100 000 tonnes/year. The process technologies of composting are very diverse. Distinctive features of different composting technologies are:

- open or closed composting
- with or without forced aeration
- different process techniques like windrow, container, box channel or tunnel composting.

Open-air windrow composting is the simplest technique. Generally, these plants work without forced aeration and waste gas collecting. Techniques with forced air systems are mostly associated with the collecting and treatment of waste gas. Combined scrubber and biofilter systems are a typical form of waste gas treatment. Different types of mechanical separation techniques are usually applied before, during or after the composting processes to sort out undesirable components from the material.

Depending on the composting technique applied and the ‘maturity’ of the compost product, the duration of the composting process ranges from a little more than a week to several months.

An important part of the composting takes place by the action of thermophilic micro-organisms at a temperature of up to 70 °C and sometimes even more. If temperatures are maintained for a sufficiently long time, pathogenic micro-organisms are killed off along with the weed seed, and the material can be considered hygienically safe.

Anaerobic digestion

Alternative to, or in combination with, aerobic composting, biodegradable waste can also be decomposed in a controlled process in the absence of oxygen. The process runs in airtight vessels, usually for several weeks, and produces methane-rich biogas (45-80% methane content). The biogas is burnt to generate electricity and/or heat. A part of the energy may be used to heat the process and keep it at the required temperature (30–60 °C). Alternatively, the biogas may be upgraded to methane and injected into the gas grid or used as a vehicle fuel.
The biogas produced will be stored before being either refined further into methane for vehicle fuel or for injection into the gas grid or burned in a combined heat and power engine to produce electricity and heat, or burned in a gas boiler to produce heat for local use
The process also produces a sludge-like or liquid residue, termed ‘digestate’, which may be used on farmland as liquid organic (NPK) fertiliser. In some plants the digestate is dewatered, resulting in a separated liquor and a separated fibre fraction. Alternatively, the digestate may be ‘cured’ by composting to further stabilise the material which can then be used as an organic fertiliser or soil improver if it is of a sufficient quality. The liquid from the process is recycled back into the process to a large extent, and the excess, if any, can be used as a liquid fertiliser if the quality allows this. Otherwise, it is disposed of into the sewerage system.

Anaerobic digestion is applied to the biodegradable fractions of MSW, agricultural wastes (excrements, litter, straw, beet and potato leaves), food industry wastes (residues from brewing, grape pressing, sugar production, slaughterhouse by-products and meat processing residues, waste water from milk processing) and sewage sludge.

Anaerobic digestion applied to MSW can use source-separated biodegradable waste as the input or mechanically separated organic fractions of MSW. The process can also imply the treatment of several streams at once, e.g. as co-digestion with agricultural residues.

Fermentation
Apart from secondary fuel production from gasification products and biogas production through anaerobic digestion, certain biodegradable wastes may be used for biofuel production through fermentation. Whereas first generation biofuels were based on energy crops such as maize, secondary generation biofuels can be based on waste material from food crops, often containing high amounts of lignocellulose The production of biofuels from these waste materials hence generally involves a step to make the material fermentable, e.g. by steam cracking of the lignocellulose parts, followed by a fermentation step yielding alcoholic fuels.

2.3 Developments in the treatment of biodegradable waste

The Landfill Directive ([11]) requires that the biodegradable waste going to landfills is reduced to

- 75 % by 16 July 2006
- 50 % by 16 July 2009
- 35 % by 16 July 2016

compared to the total amount of biodegradable municipal waste produced in 1995 or the latest year before 1995 for which standardised Eurostat data are available.

([11]) Article 5(2) of Directive 1999/31/EC of 26 April 1999 on the landfill of waste (OJ L 182, 16.7.1999, p. 1).

Member States that landfilled more than 80 % of their municipal waste in 1995 were allowed to postpone each of the targets by a maximum of four years.

The Landfill Directive requires Member States to set up a national strategy for the implementation of the reduction of biodegradable waste going to landfills. On 30 March 2005, the European Commission reported on the national strategies it had received from Denmark, Germany, Greece, France, Italy, Luxembourg, the Netherlands, Austria, Portugal and Sweden as well as on the regional plans for England, Wales, Scotland, Northern Ireland, Gibraltar, the Flemish Region and the Walloon Region. The report shows that there are large differences in the roles given to composting in the different national and regional strategies. The following three examples illustrate the diversity of the national strategies.

Austria has introduced a legal obligation to collect biodegradable waste separately, which may then be used to produce compost. As a consequence, the amount of separately collected biodegradable waste increased from a few thousand tonnes in 1989 to approximately 530 000 tonnes in 2003 (in 1995, the amount of biodegradable municipal waste produced in Austria was 2 675 300 tonnes.) This was complemented by the entry into force of an Ordinance on Composting in 2001, which regulates the quality requirements for composts from waste, the type and origin of the input materials and the conditions for their placing on the markets. Austria has already achieved the last reduction target as stated in the Landfill Directive.

Denmark has also already achieved the last target, but with a completely different strategy. An Order regarding waste issued in 2000 requires all Danish municipalities to send waste that is suitable for incineration to incineration. In recent years, only very small amounts of biodegradable municipal waste have therefore been landfilled, corresponding to far less than 10 % of the total amount of biodegradable municipal waste produced in 1995.

Italy is an example of a country that has opted for a mixed strategy. The country already fulfilled the target for 2006. In 2002, 830 0000 tonnes of biodegradable waste were diverted from landfills through:

- separate collection (3 800 000 tonnes);
- mechanical biological treatment (5 600 000 tonnes of unsorted waste with an estimated biodegradable fraction of 3 100 000 tonnes);
- incineration (2 700 000 tonnes of waste, of which about 1 500 000 tonnes was biodegradable).

Figure 1 displays the evolution of municipal waste treatment options in the EU-27 until 2008, indicating that composting grew steadily during the last decade, but recently started to stagnate[12].

([12]) http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Waste_statistics

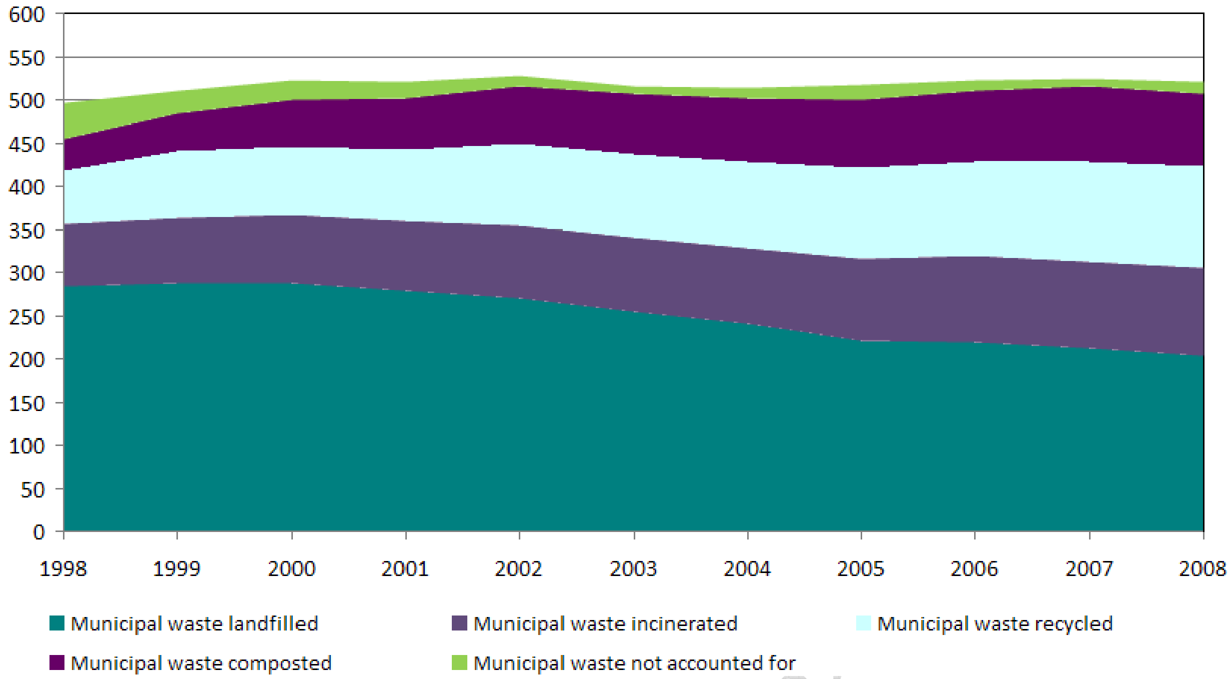

Figure 1: Waste amounts produced according to treatment options (in kg/capita) in the EU-27

A brief characterisation of biodegradable waste management in 25 EU Member States is presented in **Annex 1**.

From the stakeholder consultation following the first workshop in March 2011, additional information was received on trends and facts with regard to the treatment of biodegradable waste in various Member States of the EU.

- In *Finland*, landfilling is the most common treatment for municipal solid waste. Separate collection of biowaste started in the 90`s and it is generally only mandatory for bigger housing units. Single family houses normally are not included in the separate collection but they are encouraged to home composting. The composting of the separate collected biowaste was first done in open windrows. Several composting plants have been built at the end of the 90`s and the beginning of the second millennium. Often biowaste was treated together with sewage sludge in the composting plant. Many of the plants suffered from technical problems, because the composting systems coming from Central Europe were not adapted sufficiently to the Finnish biowaste, which is mainly kitchen waste. During the last years the interest for anaerobic digestion raised parallel with a discussion on renewable energy and an electricity tariff support. There is no complete information about the use of composts and digestate in Finland. Most of the composting and anaerobic digestion plants in Finland treat sewage sludge and green waste to some extent as well. According to the reports of regional authorities circa 190 ktonne were composted and 42 ktonne treated in AD-plants 2008. The total capacity of installed anaerobic digestion plants for biodegradable waste in Finland is about 50 ktonne.

- While the compost sector is relatively well developed in *Ireland*, the development of an anaerobic digestion industry has been slower to gain traction, which is due to the nature of proposed facilities (i.e. on farm), uncertainties in respect of subsidies available (e.g. for renewables) and requirements of Animal By-Products legislation where material from off site, other farm slurries or separately collected biowaste from the local authorities, is proposed to be treated.

- In *Spain*, in 2008, 34 plants produced 60.5 ktonne of compost from source separated biowaste, whereas 66 plants produced 493.5 ktonne of compost from mixed waste and 15 plants produced 56.1 ktonne of compost from mixed waste after digestion.

- In *Sweden*, in the decade preceding the year 2009, landfilling nearly faded out completely, whereas biological treatment of biodegradable waste increased steadily. In 2009, 536 ktonne of biodegradable waste were treated by anaerobic digestion and 631 ktonne by composting.

- In *Italy*, in 2008, about 7 Mtonne of biodegradable waste have been separately collected and recycled. About 7.5 Mtonne of municipal solid waste have been treated in mechanical biological treatment plants, yet they are disposed in landfill after the treatment. In fact no other uses are allowed for the stabilized wastes in Italy. About 4.1 Mtonne of municipal solid waste have been incinerated for energy production. A share of this waste is biodegradable. Composting plants (290 plants in total) in Italy, in 2008, have received about 3.4 million tonnes of source segregated biodegradable waste. As for anaerobic digestion in Italy, in 2008, 24.5 ktonne of digestate were produced from selected and mixed biodegradable waste sources, 52.6 ktonne of digestate were produced from selected biodegradable sources only and 6 ktonne of digestate were produced from waste from the agro-industrial sector.

- In *Belgium*, in the Flemish region, in 2009, 881 ktonne of biowaste were treated in anaerobic digestion plants, 776 ktonne were composted and 341 ktonne were biothermally dried.

- In *Slovenia*, in 2009, 32.4 ktonn of organic waste were collected, 19.2 ktonne from catering and 13.1 ktonne from households. In 2007, 2.9 ktonne of organic kitchen waste were composted and 2.8 ktonne were anaerobically digested.

- In the *UK*, according to preliminary results from the draft Annual Survey of the UK Organics Recycling Industry 2009, the organics recycling industry was composed of 281 permitted composting plants, 17 anaerobic digestion plants, 9 MBT plants and two TAD (thermal aerobic digestion) plants. Collectively, it was estimated that they recycled 5.2 Mtonne of waste. Approximately 2733 registered exempt composting sites were also identified, composting an estimated 900 ktonne of waste. Permitted aerobic composting was therefore the predominant treatment method, accounting for 90% of all sites and 90% of the waste. This composition is broadly in line with findings in previous surveys in which composting dominated; however, it is anticipated that the 17 AD plants represents the emergence of this sector, largely in response to government drivers and the promotion of anaerobic digestion nationally. Municipal waste remained the principal waste stream (just over 80%), with wastes from parks and gardens accounting for 53% overall. This probably reflects the targets placed on local authorities to recycle and divert biodegradable municipal waste from landfill, which has resulted in a comprehensive network of recycling schemes in place across all four nations of the UK.

- According to the European Compost Network (ECN), in 2009, there were about 2500 sites in *Europe* for composting of source segregated materials, 40% of which only treat garden waste, with an annual capacity of 27 million tonnes and an estimated annual capacity increase of 0.5 to 1 million tonnes. Additionally, there were 800 small agricultural co-composting plants, mainly in Germany and Austria. According to the ECN, such plants offer large potential for the rural areas of the eastern Member States. Furthermore, 195 large anaerobic digestion sites were operational in 2010, with 5.9 Mtonne capacity for organic waste, with a current capacity doubling every 5 years. Additionally, 7500 agricultural digestion and co-digestion sites for agricultural residues, energy crops and organic waste were present in Europe in 2010. The totally produced volume of digestate is estimated at 56 million m^3 for 2010, whereas the electric capacity for electricity production from biogas is 2.5 GW. Finally, there were about 280 plants in Europe, with an annual capacity of 18 million tonnes, for the mechanical biological treatment of mixed waste (by composting or digestion), mainly aimed at producing a stabilised fraction for landfilling. These plants are situated largely in Italy, Germany, Austria, France and Spain.

2.4 Compost and digestate applications

For compost, there are two main uses as a product: as a soil improver/organic fertiliser and as a component of growing media. Digestate is mainly used as an organic fertiliser with lesser soil improvement potential, except for the separated fibre fraction.

2.4.1 Compost as a soil improver/organic fertiliser

Compost is considered a multifunctional soil improver. It is therefore used in agriculture and horticulture as well as to produce topsoil for landscaping or land restoration. The application of compost usually improves the physical, biological and chemical properties of soil. Repeated application of compost leads to an increase in soil organic matter, it often helps to reduce erosion, it increases the water retention capacity and pH buffer capacity, and it improves the physical structure of soil (aggregate stability, density, pore size). Composts may also improve the biological activity of the soil.

Compost is often considered an organic fertiliser, although the fertiliser function of compost (supply of nutrients) is, in many cases, less pronounced than the general soil improvement function. According to Kluge (2008) the supply of plant-available nitrogen by compost is rather low, especially in the short term, and only repeated applications over long periods may have a relevant effect. However, the phosphate and potassium demand of agricultural soils can, in many cases, largely be covered by adequate compost application. Compost also supplies calcium, magnesium, sulphur and micronutrients and have a neutralizing value for the soil.

The effects of compost also depend on the local soil conditions and agricultural practices, and many aspects are still not well understood.

The quality parameters that characterise the usefulness of compost in agricultural applications include:

- organic matter content
- nutrient content (N, P, K, Mg, CaO)
- dry matter
- particle size
- bulk density
- pH.

2.4.2 Compost as component of growing media

The second main use of compost is as a component of growing media.

Growing media are materials, other than soil, in which plants are grown. About 60 % of growing media are used in hobby applications (potting soil), and the rest in professional applications (greenhouses, container cultures). The total volume of growing media consumed in the EU is estimated to be about 20–30 million m^3 annually. Worldwide, peat-based growing media cover some 85–90 % of the market. The market share of compost as a growing medium constituent is below 5 %. Growing media are usually blends with materials mixed according to the required end product characteristics (SV&A, 2005).

The Waste and Resources Action Programme (WRAP) together with the Growing Media Association have issued guidelines for the specification of composted green materials used as a growing medium component based on the BSI PAS 100 specifications for composted materials (WRAP, 2004). The guidelines introduce additional requirements to those of BSI PAS 100, e.g. concerning heavy metal limits.

According to these guidelines, any growing media shall:

- have a structure which physically supports plants and provides air to their roots and reserves of water and nutrients;
- be easy to use with no unpleasant smell;
- be stable and not degrade significantly in storage;
- contain no materials, contaminants, weeds or pathogens that adversely affect the user, equipment or plant growth;
- be fit for the purpose and grow plants to the standard expected by the consumer in accordance with the vendor’s description and claims.

Specifically for compost, the guidelines identify the fundamental requirements of a composted green material supplied as a component of a growing medium. It shall:

- be produced only from green waste inputs;
- be sanitised, mature and stable;
- be free of all ‘sharps’ (macroscopic inorganic contaminants, such as glass fragments, nails and needles);
- contain no materials, contaminants, weeds, pathogens or potentially toxic elements that adversely affect the user, equipment or plant growth (beyond certain specified limits);
- be dark in colour and have an earthy smell;

- be free-flowing and friable and be neither wet and sticky nor dry and dusty;
- be low in density and electrical conductivity.

According to the WRAP guidelines, such composts ‘would normally be suitable for use as a growing medium constituent at a maximum rate of 33 % by volume in combination with peat and/or other suitable low nutrient substrate(s) such as bark, processed wood, forestry co-products or coir.’ Higher rates usually affect plant growth negatively because of the compost’s naturally high conductivity.

According to ORBIT/ECN (2008), the proportion of compost in growing media depends very much on the composting process and final compost quality. The main criteria are maturation and degree of humification, concentration of mineral nitrogen components, salt content and structural stability (porosity, bulk density, aggregation) and purpose for use. In growing media for hobby gardening 40–50 % (by volume) compost can be used; in growing media for professional use 20–30 % (by volume) compost can be used. In the German quality assurance system for compost (RAL, 2007) specific criteria are laid down for compost in potting soils (growing media). Two types of compost suitable as mixing compound for growing media with different mixing volumes are described regarding stability level, nutrient and salt content.

It is important to note that compost produced with a high proportion of cooked kitchen waste is usually only suitable in lower portions as growing media component because it tends to have a higher salinity and nutrient content.

2.4.3 Digestate applications

Digestate is generally used for its fertilizing properties, given its highly available fractions of N and P, yet it also holds certain soil improving properties.

Stakeholders provided multiple examples of digestate applications in the various Member States.

- In *Germany*, the majority of the digestate is used without further treatment and only about 10% of the plants treating waste produce compost from the output of the digestion process. The liquid phase is separated after digestion and the separated fibre is generally post-composted. Only 6% of the quality assured digestate (BGK label) is produced as solid digestate in Germany. Liquid digestate (94% of whole digestate) is used directly as fertiliser in agriculture.

- In the *Netherlands*, digestate from separately collected organic waste from households always undergoes aerobic post-treatment (composting) and the resulting material is sold as fertilizer or component in growing media. It is also noted that digestate from mixed waste, even after composting, does not meet the requirements for use as fertilizer and is partially incinerated and partially land-filled, the latter route being politically discouraged.

- In *Spain*, in general digestate or separated fibre from digestate is composted, the separate liquor is treated as wastewater or it is recycled into the process. The resulting compost is mainly sold to agriculture. Besides, digestate from the co-digestion of manure with other biodegradable waste is used directly in agriculture.

- In *Sweden*, in 2009, 97% of the digestate produced from anaerobic treatment plants was used in agriculture, mostly as whole digestate. Three of sixteen plants do separate the digestate. One of them uses the separated fibre and the liquor phase in agriculture, the other two plants compost the separated fibre.

- In *Italy*, anaerobic digestion plants that treat agricultural biomass apply the digestate directly in agriculture. For anaerobic digestion plants that treat organic wastes, the resulting digestate is considered a waste and the digestate can be aerobically post-treated to produce compost according to the national fertilizer regulations or disposed.

- In *Belgium*, only professional users are allowed to apply liquid digestates, as it is assumed that these materials are not suitable for application by private users, because of a lack of stability, which implies a need for certain measures for storage and no possibility of packaging in small bags. Moreover, special equipment is necessary to be able to apply the digestate (like for liquid manure). The same remarks apply to the separated liquor, containing less nutrients and less organic matter. The other fraction, the dewatered digestate, is more concentrated in organic matter and nutrients, but is still unstable and thus not suitable for private use. Often, the dewatered digestate is (bio)thermally dried so as to obtain a dried digestate, containing a higher concentration of nutrients and organic matter on a fresh matter basis. These end products have both fertilizing and soil improving properties. In Belgium, the product is considered to be stable at a dry matter content of at least 80 % and can then be named ‘dried’ digestate. It is possible to press the dried digestate into granules in order to obtain a product easy to apply in the desired dose. In function of the market demand, some producers are aiming at a dry matter content of less than 80 %. In that case, the product is named ‘partially dried’ digestate (40-80 % dry matter). Until now, the use of these products has been restricted to professional users in Belgium. No authorizations for private use have been delivered yet. In the future, the Belgian authorities could deliver such authorizations, only for dried (stable) digestates, based on a case by case evaluation and under strict conditions, such as requirements for input materials, process monitoring, the quality of the end product as well as sustainable application of the end product.

    - In Flanders, in total 150 415 tonnes of products were produced from digestion in 2009 (whole digestate, separated liquor, separated fibre, effluent after biological treatment of liquid fraction, concentrate after filtration of liquid fraction digestate, thermally dried digestate, biothermally dried biowaste mixed with manure, biothermally dried organic soil improver). These products are mainly exported (56%). The second most important market is agriculture and horticulture (19%). The products are mainly applied on arable land. The liquid fractions are mainly used in agriculture, the solid fraction (separated fibre) is often transported towards manure processing plants (for biothermal drying) and export outside the Flemish Region.

    - In Wallonia, only one plant out of the 4 AD operating plants separates the digestate into a fibre and a liquor fraction.

- In *Slovenia*, there are currently 11 anaerobic digestion plants, of which 7 only treat agricultural biomass. Digestate is spread on agricultural land, whereby restrictions apply on the amount of nitrogen according to the Decree concerning the protection of waters against pollution caused by nitrates from agricultural sources (Official Gazette of the Republic of Slovenia, no. 113/09). The other 4 anaerobic digestion plants treat mainly catering waste, slurry and silage (corn) and the digestate (mainly liquid) is also spread in agriculture when it meets the requirements of the Decree on the treatment of biodegradable waste (waste legislation).

- According to the *UK* Association for Organics Recycling, whole digestate may be suitable for use as biofertiliser, soil conditioner and, if sufficiently low in dry solids content, as foliar feed for plants. Separated liquor may be suitable for use as biofertiliser, soil conditioner and, if sufficiently low in dry solids content, as foliar feed for plants. Separated fibre may be suitable for use as biofertiliser, soil conditioner and mulch.

- According to the European Compost Network, the following trends are noted with regard to digestate use:
  - Wet fermentation of biowaste biogas plants:
    - In Central/Western Europe: the output is separated into a liquid and solid fraction whereby the solid fraction is post-composted and the excess liquid fraction that is not recycled to the process is mostly applied to agricultural land
    - In Scandinavia: the complete digestion residue is applied on agricultural land
  - Wet fermentation of energy crops, manure and industrial / commercial waste (food industries, restaurants, former foodstuff etc.): the complete digestion residue is applied on agricultural land
  - Dry fermentation: the solid digestion residue is generally post-composted together with bio-/green waste
  - Approximately less than 3% of the digestates are further treated to specific products e.g. for pellets or as constituents for growing media or manufactured soils.

- According to the European Biogas Association, new products like dried or pelletized digestates are increasingly released into the European market. With full upgrading by ultrafiltration and reverse osmosis, highly concentrated fertiliser and a purified aqueous stream of drinking water quality can be produced. These developments are rather new. Today, still more than 95% of the produced digestate in Europe is used directly in the agricultural sector as a liquid fertilizer.

In conclusion, it can be stated that digestate is often used in agriculture, either as a whole digestate fraction or following separation in a solid and liquid fraction. The solid fraction may undergo additional treatments such as post-composting or drying. The liquid fraction, when not used on agricultural land, may undergo a treatment similar to wastewater to produce a clean water fraction.

2.5 Economic and market aspects

This section characterises the compost and digestate market in the EU in terms of current compost and digestate supply and use, imports and exports, production costs, prices, and the agronomic value of compost and digestate. It also presents a market outlook for both materials.

2.5.1 Compost supply

ORBIT/ECN (2008) estimated that the yearly production of compost in the EU in 2005 was more than 13 million tonnes (compost from the biodegradable fraction of MSW and sewage sludge). When extrapolating from the partially new data received following the stakeholder survey in December 2010, it is expected that compost production grew slightly from 2005 to 2008.

Only a few countries make up most of the compost production from MSW in the EU. In absolute amounts, Germany is the biggest compost producer with about 4.4 million tonnes, followed by France, the United Kingdom, the Netherlands and Italy. On a per capita basis, compost production is highest in the Netherlands, followed by Austria, France and Germany. Of these countries, Germany, the United Kingdom, the Netherlands and Austria rely mainly on source-separated biodegradable fractions of MSW for compost production. In France and Spain, compost is also produced in considerable quantities from mixed MSW with a growing market share of MBT compost in France. France, Spain and Italy also produce sizeable amounts of sewage sludge compost. In the 12 new Member States, compost production plays a very small role. Table 1 presents compost production data country by country.

Apart from MSW and sewage sludge, compost can also be produced from wastes from agriculture, forestry, and the food and drink industries. The quantities of composts produced from these sources are unknown but are assumed to be much smaller than from MSW and sewage sludge.

Table 1: Compost produced in the EU (tonnes/year). Source: ORBIT/ECN (2008) and stakeholder survey December 2010

	Year	**Total**	**Biowaste (except green waste) compost**	%	**Green waste compost**	**%**	**Sewage sludge compost**	**%**	**Mixed waste compost**	**%**	**Other composts**	**%**
AT	2005	**634,400**	218,400	34	380,000	60	32,000	5	4,000	1		0
BE/Flanders	2009	**344856**	115,150	33	229,706	67	0	0	0	0		0
BE/Wallonia	2008	**152,954**	11,892	8	120,129	79	20,933	14	0	0		0
BG		**0**	0		0		0		0			
CY		**0**	0		0		0		0			
CZ	2006	**77,600**	4,000	5	21,600	28	52,000	67	0	0		0
DE	2008	**4,384,400**	2,048,600	47	1,599,000	36	627,600	14	0	0	109,200	2
DK	2008	**374,530**	17,600	5	315,600	84	41,330	11	0	0		0
EE		**0**	0		0		0		0			
ES	2008	**610,148**	53,969	9	6,549	1		0	549,630	90		0
FI	2005	**180,000**	150,000	83		0	30,000	17		0		0
FR	2005	**2,490,000**	170,000	7	920,000	37	800,000	32	600,000	24		0
EL	2005	**8,840**	0	0	840	10	0	0	8,000	90		0
HU	2005	**50,800**	20,000	39	30,800	61	0	0	0	0		0
IE	2006	**100,500**	25,000	25	34,000	34	17,000	17	24,500	24		0
IT	2008	**1,004,952**	802,340	80	176,804	18		0		0	25,808	3
LT		**0**	0		0		0		0			
LU	2005	**20,677**	20,677	100	0	0	0	0	0	0		0
LV		**0**	0		0		0		0			
MT		**0**	0		0		0		0			
NL	2008	**1,603,464**	595,464	37	1,000,000	62	8,000	0	0	0		0
PL		**0**	0		0		0		0			
PT	2005	**29,501**	2,086	7	1,730	6	2,500	8	23,185	79		0
RO		**0**	0		0		0		0			
SE	2008	**199,700**	71,700	36	116,000	58	0	0	12,000	6		0
SI		**0**	0		0		0		0			
SK	2005	**32,938**	1,836	6	27,102	82	4,000	12	0	0		0
UK	2005/06	**2,036,000**	316,000	16	1,660,000	82	15,000	1	45,000	2		0
EU-27		**14,358,104**	**4,651,864**	**32**	**6,654,554**	**46**	**1,650,363**	**11**	**1,266,315**	**9**	**135,008**	**1**
Bio and green waste compost					**11,306,418**	**79**						

2.5.2 Compost use

The suitable uses of compost depend on source material type, compost class and quality. Application areas like agriculture just require standard quality. Landscaping and, even more so, the growing media sector need an upgraded and more specialised product. Here, further requirements of the customers have to be met and it is up to the marketing strategy of the compost plant to decide whether to enter into this market segment.
Compost producers often face difficulties in marketing because they lack understanding of the potential use sectors such as the landscaping and horticultural sectors (e.g. knowledge of plant growing and the related technical language). Declaration, advertisement and marketing are not always of a standard comparable with competing products.

Table 2 provides an overview of compost use in the main compost producing countries in the EU.

Table 2: Compost use distribution (%) in major compost producing countries. Source: ORBIT/ECN (2008).

	AT 2003	BE/ Fl 2009	DE 2005	ES (1) 2006	FI 2005	FR (2) 2005	HU 2005	IE 2006	IT 2003	NL bio-waste 2005	NL (1) green waste 2005	PL (2) 2005	SE 2005	UK 2005	Weighted Mean EU(3)
Agriculture	40.0	11	53.4	88.0	20.0	71.0	55.0	37.0	51.0	74.8	44.4	—	—	30.0	50.9
Horticulture & green house production	10.0		3.9	8.0	—	25.0	15.0	3.0	—	—	15.5	—	5.0	13.0	10.6
Landscaping	15.0	38	15.9	4.0	20.0	—	10.0	6.0	6.0	3.6	12.3	—	20.0	14.0	10.4
Blends	15.0	44	13.6	—	10.0	—	—	16.0		15.0	5.1	—		2.0	6.3
Soil mixing companies	2.0		—	—	—	—	—	—	—	—	9.4	—	10.0	—	1.6
Wholesalers	—		—	—	—	—	—	—	—	—	5.2	—	15.0	—	0.9
Hobby gardening	15.0		11.9	—	—	4.0	5.0	—	27.0	1.1	2.3	—	10.0	25.0	12.9
Land restoration and landfill cover	2.0		—	—	50.0	—	15.0	38	2.0	—	—	100.0	40.0	16.0	4.9
Export	1.0	6	—	—	—	—	—	—	—	5.5	5.0	—	—	—	1.0
Others	—	2	1.3	—	—	—	—	—	—	—	0.8	—	—	—	0.5

(1) Green waste compost. ; (2) Mainly mixed waste compost; (3) Weighted by data from Table 1

An important factor determining compost use is the national environmental and fertilising policy. The manure policy in Belgium, for instance, makes it very difficult to sell compost to farmers. The excess of manure encountered in Flanders compared to the agricultural surface available implies that the limits of organic nitrogen levels are rapidly reached through manure spreading and that only 11 % of the compost goes to agriculture. This situation is not encountered in Wallonia, such that up to 57% of the compost produced goes to agricultural soils in that region. In the Netherlands, however, with the same animal husbandry and nutrient situation, most of the kitchen/biowaste compost is used in agriculture (75 %).

In Europe, more than 50 % of the compost goes to mass markets which require standard quantities. Twenty to thirty per cent of the market volumes are used in higher specialised market areas which require an upgrade and mixing of the compost in order to meet the specific requirements of the customers.

In recent years, the use distribution in countries with developed markets (such as Flanders in Belgium, Germany and the Netherlands) was relatively stable. Changes in the fertiliser legislation in the Netherlands have, however, led to a reduced share of agricultural use after 2005.

2.5.3 Compost imports and exports

According to ORBIT/ECN (2008), the main compost exporting countries in the EU are probably Belgium and the Netherlands. On average, they exported 4.5 % of their annual production in 2005 and 2006. The main reason for exports in these cases was a low national demand because of strong competition of other cheap organic material (mainly manure). However, the Netherlands informed that competition with manure is no longer an issue for Dutch agriculture according to the feedback received following the stakeholder survey.

Generally, compost plants supply their product within 50 km of the plant. This corresponds to the distance a large lorry of 25 tonnes capacity can make within an hour for the cost of EUR 50–60. These transport costs and the other marketing expenses are still covered by prices of around EUR 5/tonne (EUR 125/lorry load). All plants close to borders (less than 50 km distance) contacted by ORBIT/ECN underlined the importance of this local market and expressed their appreciation of the end-of-waste provisions which could potentially help them to overcome the constraints of selling their compost over the border.

ORBIT/ECN reports not having detected a ‘real import demand’ for compost. The low value per weight of compost does not cover the cost of the transport to the areas where the main needs exist, such as the Mediterranean countries.

The main continuous import and export activities and potentials are related to the growing media sector. Using compost in various products based on green waste are a common business especially for the large international companies producing and dealing with peat, soil and bark. However, growing media products containing compost as one of the components are generally not considered subject to waste legislation.

2.5.4 Production costs and compost prices

The costs of composting depend on local conditions and the quality of the material to be composted. Eunomia (2002) reviewed the information from various sources regarding the cost of composting source-separated biological waste, and made a cost estimate of EUR 35–60/tonne of waste for larger ‘best practice’ plants in closed systems, although higher costs had also been reported in some cases. The cost of low-tech windrow composting may be less than

EUR 20/tonne of waste. There are also some cost differences between countries following the general tendencies of producer prices. Gate fees charged for green waste tend to be smaller than for kitchen waste or for mixed kitchen and green waste.

The price of bulk compost for use as an organic fertiliser or a soil improver is much lower than the ‘production costs’, i.e. the costs of treating biological wastes in a composting plant. The prices achieved for composts for agricultural use in central Europe are rarely higher than EUR 5/tonne of compost and, in most cases, lower. Often, the compost is actually given away to farmers free of charge. A typical scenario in Germany is that the compost producer offers the transport, the compost and the spreading of the compost on the field as a service to the farmers (usually through subcontractors) and charges about EUR 1–2/tonne for everything.

Compost sales to agriculture become very difficult when there is a fierce competition with manure. This is the case in Flanders and the Netherlands, where, on account of the huge animal husbandry, a surplus in manure arises and up to EUR 30/tonne of manure is paid to the users. This and a restrictive application regulation make it difficult to sell compost for agricultural uses in those countries (ORBIT/ECN, 2008).

A French compost market study for ADEME (2006) reports the following price ranges for compost use in agriculture (grandes cultures):

- compost from green waste: EUR 0 (in most cases) to EUR 10–12/tonne (including the cost for transport and spreading)
- compost from mixed MSW: EUR 0 (most frequently) to EUR 2–3/tonne (including spreading).

The combined separation-composting plant for MSW at Launay Lantic (France) sells most of the compost produced to artichoke or cauliflower growers at a price of EUR 2.34/tonne (personal communication).

In Austria, decentralised composting plays an important role and often farmers run small and simple windrow composting facilities in which they treat source-separated biological waste from nearby municipalities. The farmers use the compost on their own farmland, and if their farmland is of a suitable size, there is no need for these compost producers to sell or give away the compost. For the highest quality compost, which is suitable for organic farming, prices of a little more than EUR 10/m^3 have been found. An example of the gate fee charged by a ‘farmer-composter’ in Austria is EUR 48/tonne biowaste from separate collection.

In 2001, the average sales price for compost made from pure garden and park waste in Denmark were reported to be about EUR 8–9/tonne (Hogg et al., 2002).

According to ORBIT/ECN (2008), soil manufacturing companies and blenders are interested in getting cheap raw material and are therefore not willing to pay high prices, so sales prices range from EUR 2.40 to EUR 3.20/tonne.

Landscaping and horticulture require medium efforts in product development and marketing, which reflect the price of EUR 6–15/tonne. Hobby gardening prices are on a similar level. Relatively high prices from EUR 90 to EUR 300/tonne follow from situations where the compost is sold in small bags, e.g. as blends, to hobby gardeners or to wholesalers. Bulk deliveries to wholesalers, however, only lead to about EUR 7/tonne. However, in most cases such prices are only obtained for a minor fraction of the total compost production of a plant (typically 1% or less). As such, the sales of compost to private end-users serves more in raising awareness on the need for good recycling of biodegradable materials.

An interesting approach to generate higher revenues from compost is applied in certain compost plants in Germany. An external company provides the marketing tools, such as billboards, information folders etc. The local plant operator prepares the mixtures according to prescriptions and pays the marketing company based on the amount of compost products sold in bulk or bagged. In order to encourage citizens to respect source separation guidelines for biowaste collection and to create trust in the manufactured compost products that they purchase, references are made to regional affiliations on the compost bags. In this way, the consumers understand that the compost bought is the output of their proper collection and sorting efforts.
Using this marketing approach, plants do not only guarantee good compost quality, but they are also able to combine high turnover to private customers with high revenues. In this way, they can sell around 30% of the compost production to private end-users and generate prices of up to 20 Euro/m^3 for compost and even higher prices for compost blends. A requirement for such a strategy is that the compost plant is situated in areas with a considerable number of garden owners.

Figure 2: Billboard outside composting plant (Weiterstadt, Germany) indicating prices of locally produced compost and compost based goods

Unless sizeable proportions of the compost produced can be sold to outlets other than agriculture for higher prices, the financial feasibility of the composting plants essentially depends on the gate fees charged for the treatment of the wastes used as input or on subsidies. According to ORBIT, this is true for all European countries. Ninety-five per cent of the plants rely on the gate fee. Only very few companies have developed their local market so well that compost sales contribute substantially to their economic feasibility. In most cases, only a relatively moderate pressure exists for entering into the revenue-oriented high price markets, which requires additional efforts and competence in market and product development and marketing.

The low value per tonne of compost soil improvers and fertilisers is a strong limitation to the distances over which the transport of compost for agricultural uses makes economic sense. Transportation over more than 100 km for agricultural uses will only be feasible if there are specific areas where agriculture has an exceptionally strong demand for organic fertilisers that cannot be satisfied from local sources or if the waste management sector ‘cross-subsidises’ the transport cost (negative prices of the compost before transport). The latter is likely to occur if the alternative treatments for biological waste, such as landfill or incineration, are more expensive than composting.

2.5.5 Agronomic value of compost

ORBIT/ECN (2008) estimated the agronomic value of compost based on the fertiliser prices published on 10 April 2007 by the Chamber of Agriculture of North Rhine-Westphalia. For example, fresh compost produced from kitchen and garden wastes, rich in nutrients and well structured, and declared as organic NPK fertiliser 1.40 (N)–0.60 (P_2O_5)–1.02 (K_2O) has a nutrient value of EUR 8.49/tonne fresh matter. The fertiliser value of well-structured compost with lower nutrient contents (organic PK fertiliser EUR 0.43/kg P_2O_5–EUR 0.22/kg K_2O) was calculated to be EUR 3.93/tonne fresh matter. The nitrogen content was calculated on the basis of the available contents. The contents of phosphorus and potassium were calculated at 100 % on recommendation of agricultural consultants.

In addition to the nutrient value, ORBIT/ECN also calculated the humus value for an average compost application (ca 2 800 kg humus-C/hectare incorporated within a three-year crop rotation). Taking the substituted supply costs of humus via ‘green manuring’ with *Phacelia* or *Sinapis arvensis* and/or straw sale as the reference, the humus value of compost was calculated to be EUR 3.28/tonne fresh matter.

Comparing this with compost prices for agricultural use, it appears that the agronomic value can be substantially higher than the price paid for it.

According to the German Quality Assurance Organisation of Compost (BGK), the fertiliser value for compost (with 8.3 kg N/tonne fresh matter, 3.8 kg P_2O_5/ tonne fresh matter, 6.8 kg K_2O/ tonne fresh matter and 25.1 kg CaO/ tonne fresh matter) was 11.26 Euro/ tonne fresh matter in April 2011. When including the organic matter, the monetary value of compost is calculated at 22.82 Euro/ tonne fresh matter.

2.5.6 Market outlook for compost

In this section, the theoretical potential of compost production from the source-segregated biodegradable fractions of MSW is estimated and compared to the theoretical compost use potential. Also, the amounts of alternative materials, which can be used instead of compost, are estimated.

Compost production potential

According to Eurostat[13], 524 kg of municipal waste was generated per person in 2008, of which about 88 kg or 17% was composted. In absolute figures, this implies 44.5 million tonnes of MSW being composted. These figures hardly changed from the 2007 data.

Based on ORBIT/ECN study (2008), about 29.5 % or 23.6 million tonnes of the estimated total recoverable potential of the 80 million tonnes organic waste fractions was separated *at the sourc*e and treated predominantly through composting. This corresponds to an average per capita biowaste and green waste collection rate of about 50 kg/year.

Experience in certain countries showed that a collection rate of up to 180 kg/capita/year of source-separated organic waste suitable for biological treatment can realistically be achieved (for example in the Netherlands or Austria). A reasonable and realistically achievable European average rate might be 150 kg/capita/year (ORBIT/ECN 2008). Using this as a reference, it would imply a potential of separate biowaste and green waste collection in the EU of about 80 Mtonne/year. If all this were used for compost production, 35–40 Mtonne of compost could be produced per year. Table 3 shows estimates of current amounts of separately collected wastes as well as of the maximum potentials for the 27 Member States of the EU.

Table 3: Potential and actual amounts of biowaste and green waste collected for composting in the EU-27 (1 000 tonnes).

Source: ORBIT/ECN (2008).

		Potential quantities			**Separately collected today (without home composting) (3)**			**Separately collected (% of total potential)**
	Total MSW (1)	**Biowaste**	**Green waste**	**Total (2)**	**Biowaste**	**Green waste**	**Total**	
AT	3 419	750	950	1 700	546	950	1 496	88
BE	4 847	n.d.	n.d.	2 573	n.d.	n.d.	885	34
BG*	3 593	n.d.	n.d.	1 164	0	0	0	0
CY*	554	n.d.	n.d.	112	0	0	0	0
CZ	3 979	1 354	180	1 534	10	123	133	9
DE	37 266	8 000	8 000	16 000	4 084	4 254	8 338	52
DK	3 988	433	750	1 183	38	737	775	66
EE	556	195	130	325	0	0	0	0
ES*	25 694	n.d.	n.d.	6 456	n.d.	n.d.	308	5

(13) Eurostat news release 43/2010 http://epp.eurostat.ec.europa.eu/cache/ITY_PUBLIC/8-19032010-AP/EN/8-19032010-AP-EN.PDF

		Potential quantities			Separately collected today (without home composting) (3)			Separately collected (% of total potential)
	Total MSW (1)	Biowaste	Green waste	Total (2)	Biowaste	Green waste	Total	
FI*	2 451	n.d.	n.d.	785	350	100	450	57
FR*	46 000	n.d.	n.d.	9 378	300	2 400	2 700	29
EL*	4 854	n.d.	n.d.	1 662	0	2	2	0
HU*	4 446	n.d.	n.d.	1 515	n.d.	n.d.	127	8
IE*	3 041	n.d.	n.d.	616	52	71	123	20
IT	31 687	n.d.	n.d.	8 700	2 050	380	2 430	28
LT*	1 295	n.d.	n.d.	514	0	0	0	0
LU*	321	n.d.	n.d.	68	n.d.	n.d.	52	76
LV*	715	n.d.	n.d.	346	0	0	0	0
MT*	246	n.d.	n.d.	60	0	0	0	0
NL*	10 900	n.d.	n.d.	2 446	1 656	1 700	3 356	137 (4)
PL*	9 353	n.d.	n.d.	5 726	n.d.	n.d.	70	1
PT	4 696	n.d.	n.d.	1 579	24	10	34	2
RO*	8 274	n.d.	n.d.	3 249	0	0	0	0
SE*	4 343	n.d.	n.d.	1 352	125	250	375	28
SI*	845	n.d.	n.d.	300	0	0	0	0
SK*	1 558	n.d.	n.d.	808	5	68	73	9
UK*	35 075	n.d.	n.d.	9 009	n.d.	n.d.	1 872	21
EU-27	257 947			80 101			23 598	29.5

(1) Source: Eurostat website (http://epp.eurostat.ec.europa.eu).
(2) In most cases individual estimations by national experts were missing. For all Member States marked with an asterisk (*) the realistic potential of biowaste and green waste collection is based on the assumption of 150 kg/capita/year.
(3) The estimation of currently collected biowaste and green waste was provided by national experts contacted during the elaboration of this study (see acknowledgments). The reference year was 2005.
(4) The Netherlands with 200 kg/capita/year bio and green waste collection has already exceeded the mean potential estimated with 150 kg/capita/year. This leads to 137 % collected against potential.

Furthermore, the potential for the production of compost from sewage sludge was estimated to be from 5 to 10 Mtonnes/year. The potential for the production of compost from other organic materials cannot reasonably be quantified, because of the very heterogeneous properties even within one sub-waste stream (e.g. market wastes). The suitability of treating those materials in an aerobic composting process depends on the composition, degradability, water or nutrient content (C/N ratio). Composting is not always the first choice. Most of the food and vegetable residues, for instance, are very wet which makes them more suitable for anaerobic digestion. For bark and wood, energy generation might sometimes be the preferred option.

Compost use potential

ORBIT/ECN (2008) suggests a simple calculation to illustrate that the theoretical potential for compost use, in agriculture alone, is much higher than the theoretical compost production potential from biowaste and green waste. The calculation is reproduced in Table 4. Similar conclusions were obtained by calculations of this type at the level of individual Member States. Furthermore, there are specific compost market studies for Germany, Ireland, Spain, France and the United Kingdom (most of them reviewed by ORBIT/ECN) that all conclude that there is sufficient potential for use of high-quality compost.

Table 4: Comparison of compost production and agricultural use potentials in the EU.

Source: ORBIT/ECN (2008).

Present situation in EU	Amount
Amount of collected bio and green waste	23 600 000 tonnes
Amount of compost produced in the EU-27	11 800 000 tonnes
Arable land for plant production in the EU-27	123 391 000 ha ([14])
A typical application rate of 10 tonnes compost/year needs	1 800 000 ha
Portion of the total arable land needed to absorb the compost	1.5 %
Theoretical compost production potential (maximum)	**Amount**
Potential for collected bio and green waste	80 000 000 tonnes
Potential amount of compost produced in the EU-27	40 000 000 tonnes
Arable land for plant production in the EU-27	123 391 000 ha
A typical application rate of 10 tonnes compost/year needs	4 000 000 ha
Portion of the total arable land needed to absorb the compost	3.2 %

<u>Substitute materials for compost</u>

As soil improvers, agricultural residues — first of all straw and manure — can create a similar benefit to compost by fertilising the soil and delivering organic matter. According to ORBIT/ECN (2008), the effect on humus reproduction is, however, much higher of compost than of these materials. In the EU, there are from 1.5 to 2 billion tonnes of agricultural residues per year.

Plant nutrients contained in compost can substitute, to some extent, mineral fertilisers. In Germany for example, the substitution potential for phosphate is 28 000 tonnes, which corresponds to 10 % of the phosphate of the mineral fertilisers applied in Germany. These potentials are 9 % (43 000 tonnes) in the case of potassium and 8 % (175 000 tonnes) in the case of lime fertilisers.

Compost also competes with the land spreading of sewage sludge. Some 4 Mtonne (dry matter) treated sludge from municipal waste water treatment was used in agriculture in 2006 in the EU-27.

([14]) Source: Eurostat. Statistik kurz gefasst. Landwirtschaft und Fischerei 86/2007. Europäische Gemeinschaften 2007.

In growing media, compost can partly substitute peat and bark. Bog peat is still the overall predominant growing medium constituent in the EU. This is also true for Member States without domestic peat production. Peat-free growing media are highly esteemed by some stakeholder and user groups but still play a relatively minor role in the industrial production of growing media. For technical reasons, bark, coir and compost can only partly serve as substitutes for peat.

In 2005, 0.95 million m^3 compost and 2.05 million m^3 bark (including wooden materials) were used in growing media (ORBIT/ECN, 2008).

2.5.7 Digestate supply

The total amount of digestate produced in Europe is estimated at 56 Mtonne fresh matter/year ([15]). However, it should be noted that not all of the digestate produced is derived from biodegradable waste only. In view of the high prices paid for electricity produced from biogas (up to 0.3 Euro/kWh), digestion plants frequently rely on energy crops as input material for biogas production.

In the EU-27, *Germany* is the major producer of digestate, with about 36.5 Mtonne digestate produced annually. The majority of digestate is a residue from the biogas production from energy crops, which is financially stimulated through the revenues from green electricity production. Digestate produced from biowaste amounts to only a small fraction of the total digestate produced, with 2.84 Mtonne fresh matter/year (2008 data). In the German quality assurance system for digestate (RAL GZ 245/246) of BGK 2.5 million tonnes fresh matter of digestate are quality assured. A number of 84 digestion plants treat biowaste and 15 digestion plants treat only renewable energy crops under the BGK QAS. The main input materials are: renewable energy crops (24%), biowaste from households through biobin (22%), manure (20%), food waste (14%), fats (10%), former foodstuff (7%) and diverse biowaste (3%). About 93% of the input streams used in anaerobic digestion plants treating waste, based on the German waste statistics, consists of following waste streams: wastes from agriculture, horticulture, aquaculture, forestry, hunting and fishing (30.99%), waste from the production of food of animal origin (21.02%), waste from the production of food of plant origin (14.21%), municipal sewage sludge (3.14%), commercial food waste (6.84%), green waste (2.75%), biobin waste from households (14.23%). According to the European Biogas Association, 27 million tonnes of manure are fed into anaerobic digesters in Germany for the production of biogas, and there is a potential to increase this number to 150 million tonnes. Furthermore it is stated that Germany produces 75% of all biogas in Europe. Sewage sludge is not allowed in Germany as input material as in German legislation, the Sewage sludge ordinance takes precedence.

In *Sweden* 389 ktonne fresh matter/year digestate was produced in 2008 (with an average dry matter content of 10%). The input material for anaerobic digestion consisted of source separated biodegradable fractions of municipal solid waste (17%), commercial food waste (18%), manure (24%), slaughterhouse residues (29%) and other biodegradable wastes (12%).

In the *Netherlands*, at the end of 2009, eight plants had a license to ferment separately collected organic waste from households. These eight plants had a combined licensed capacity of 611

([15]) E-mail comunication with the European Compost Network (1 February 2011) ktonne. Of these eight, only two actually did digest some material (together 81 ktonne). Besides these 8 plants that are licensed to digest separate collected biowaste also two installations are operational that use mixed waste (separation and digestion). The capacity of the digestion part of these installations in both cases is about 90 ktonne. The digestate from these installations does not meet the criteria to be used as fertilizer.

In *Italy*, in 2008, the amount of digestate produced from source segregated biowaste is 52.6 ktonne (fresh matter). In addition to this, digestate is also produced from mixed wastes and from agricultural wastes. The CIC (Italian Consortium for composting) estimates for the year 2010 a production of 400 ktonne fresh matter. Digestate from biodegradable source separated wastes is used to produce compost with the requirement of the fertilizer national law (product).

In Flanders (*Belgium*), in 2010, around 800 ktonne fresh matter of digestate was produced, with the large majority ending up as mushroom substrate or biothermally dried compost for export. 100 ktonne of source separated vegetable fruit and garden waste were digested in mono-digestion, whereas 749 ktonne of organic biological waste were co-digested with 415 ktonne of manure and 149 ktonne of agricultural residues or energy crops.

In the *UK*, estimated quantities of whole digestate manufactured in 2009 were 124 ktonne. The quantities reported for separated fibre and separated liquor for the same year were only respectively 380 and 80 tonnes. Almost similar proportions of municipal (25.4 ktonne) and non-municipal wastes (23.1 ktonne) were digested (52% and 48%, respectively), which was in sharp contrast to the composting sector where the ratio was 80% and 20%, respectively. This implies a reduced reliance on wastes supplied by local authorities, and a more diversified business model, sourcing wastes from the commercial and industrial sector. Within the municipal waste category, the majority comprised biodegradable kitchen and canteen wastes (EWC code 20 01 08; 56%; 14 ktonne), although mixed municipal wastes (20 03 01) comprised 25% (6 ktonne). The latter were only accepted at a single site in Scotland. Waste from markets (20 03 02) made up 11% (2.76 ktonne), whilst edible oils and fats (20 01 26) were 5% (1.3 ktonne). Wastes from non-municipal sources were split between wastes from agricultural, horticultural, hunting, fishing and aquacultural primary production, food preparation and processing) at 40% (9.2 ktonne) and wastes from waste treatment facilities, offsite waste water treatment plants and the water industry at 60% (13.9 ktonnes). The latter comprised just less than 14 ktonne of "digestate from anaerobic treatment of animal and vegetable waste" (19 06 06) at one AD plant.

Further data on digestion facilities for biowaste (source separated organics) and municipal solid waste is provided in a study by De Baere and Mattheeuws (2010). They made an inventory of the existing plants, contracted installations and plants under construction in several EU member states (Table 5). Following criteria were taken into account

- At least 10% of organic solid waste from household origin needs to be treated in the plant, with a minimum capacity of 3 ktonne per year.
- The capacity taken into consideration is the designed capacity for the plant, unless specified differently by the supplier/operator. For biowaste, the total capacity of the biowaste plant was used while for mixed and residual waste plants, the actual capacity going into the digesters was used.
- Plants were not eliminated if their operation ceased.
- The plants taken into consideration have to be at least under construction or contracted and situated in Europe.

Table 5: Installed capacity of anaerobic digestion plants for biowaste and municipal solid waste (De Baere and Mattheeuws, 2010)

	Total capacity (tonnes/year)	**Average capacity (tonnes/year)**	**Number**
AT	84,500	12,071	7
BE	173,700	34,740	5
DE	1,732,805	23,104	75
DK	31,000	40,500	1
ES	1,495,000	59,563	25
FI	15,000	15,000	1
FR	862,000	66,308	13
IT	397,500	36,136	11
LU	23,000	11,500	2
MT	45,000	45,000	1
NL	476,500	59,563	8
PL	52,000	13,000	4
PT	85,000	21,250	4
SE	40,000	10,000	4
UK	202,500	40,500	5
Total	**5,715,505**		**166**

2.5.8 Digestate use

Europe-wide, the majority of the digestate is recycled in agriculture (80-97%). It is estimated that the overall ratio of digestate to compost use on farmland is about 1/10 in countries with a well developed compost market.

In *Germany*, nearly all digestate is used in agriculture. In *Sweden*, 96% of the digestate goes to agriculture.

In the *UK*, all of the reported whole digestate, liquor and fibre was applied to agricultural land. The main type of agricultural crop to which whole digestate was applied was grassland (52%), whilst 43% was applied to cereals / combinable crops. The relatively small quantities of fibre and liquor were applied predominantly to cereals and other combinable crops.

In *Slovenia*, when the digestate produced from biowaste meets the requirements of the Decree on the treatment of biodegradable waste of quality Class I, it can be spread on agricultural land without restrictions. When the digestate meets the requirements of quality Class II, it can be used on agricultural land with the permit of the competent authority and in horticulture and landscaping without restrictions. The quality classes are the same for compost and digestate.

Although the official statistical figures for Germany indicate that 110 ktonne of digestate are composted, the European Biogas Association states that in practice 250 ktonne of digestate are post-composted, but the anomaly stems from the fact that the resulting material is not always being declared as compost.

2.5.9 Digestate imports and exports

Very few Member States mentioned current exports or imports of digestate. *Sweden* and the *Czech Republic* explicitly mentioned not importing or exporting digestate.

Import or export of digestate is more likely to happen in smaller countries with a large digestate production and reduced uptake possibilities in the own market. As such, digestate is exported from the Flemish Region towards a.o. France, after it is treated in manure treatment plants with ABPR recognition (1069/2009), or when sanitised in the digestion plant. This is mainly the solid fraction of digestate (20-25% dry matter), digestate after biothermal drying (40-45% dry matter) or thermally dried digestate (65-85% dry matter). No liquid digestate is exported, except as incubation material to set up new anaerobic digestion plants abroad. There is very few import of digestate because of manure legislation in Flanders hampering the input of extra nutrients into agriculture. A negligible part of digestate is exported from Wallonia (due to the fact that some fields from the producer are located in another country), and no import occurs.

2.5.10 Digestate production costs, gate fees and digestate prices

According to the European Biogas Association, production costs range from 10 to 30 Euro per tonne for biowaste treatment through anaerobic digestion, *excluding* investment costs. The figure depends on the technology used and the quality and purity of the input materials. Gate fees also largely vary on local conditions and regulations and especially on the energy content of the feedstock. For certain lipid derived materials with high gas potential, anaerobic digestion operators are even willing to pay for the waste.

The sales price for digestate is generally slightly lower than for compost. Positive prices are seldom encountered and the digestion plants commonly pay intermediate companies or farmers for the landspreading of digestate. Furthermore, digestate is rarely sold at cost covering prices, with an average maximum price of 3 to 5 Euro/tonne for whole digestate. In the best cases, solid and post-composted digestates can be sold for up to 10 Euro per tonne. Noteworthy, however, is that dry pelletized digestates can reach prices of up to 150 Euro per tonne in the agricultural market. Additionally, digestates in all forms can reach higher prices when sold for private consumer use.

According to the European Biogas Association, several thousands of tonnes of dried digestate produced from energy crops and manure are already available in the market and sold to fertiliser factories as well as transported across the borders. Prices range from 5 - 30 € per tonne depending on the feedstock, content of nutrients and quality.[16]

Treatment costs for composting and digestion in *Germany* are reported to be between 30 and 80 Euro per tonne. Additional composting following digestion adds an additional cost up to 30 Euro per tonne.

[16] According to a personal communication with a producer of dried digestate in Belgium, prices of dried digestate fluctuate in line with market prices for industrial fertilizers.

In the *Czech Republic*, there are only a few waste anaerobic digestion plants. Plant owners are facing serious difficulties to receive sufficient input of source separated biowaste, due to cheap landfilling, low enforcement of biowaste diversion targets from landfills and catering waste shredders, which are very common in every catering facility even if they are not legally operated. Furthermore, anaerobic digestion plants usually have to pay 1 to 5 Euro/ tonne wet material for post-composting of digestate. The gate fee for waste treatment is very low to keep competition with landfilling and avoid direct shredding of biodegradable waste into the wastewater. Gate fees are hence at 0-15 Euro/tonne, compared to 30-40 Euro/tonne for landfilling.

In *Spain*, in Catalonia, production costs for digestate from source separated biowaste are estimated at between 60 and 90 Euro/tonne of biowaste.

Gate fees in *Belgium* are reported at 20 Euro/tonne for manure and 15.6 Euro/tonne for other organic biological waste.

In *Slovenia*, digestate is given away free of charge to farmers.

In the *UK*, gate fees for digestion sites are generally higher than for composting sites at £57 (approximately 65 Euro) per tonne. The income from sale of digestate was found to be low, with a pecuniary value of only £3 (approximately 3.5 Euro) per tonne. The financial value of anaerobic digestate is estimated at £7 (approximately 8 Euro) per tonne. Although most digestate is currently going to agriculture, it could offer a cost effective alternative to expensive commercial fertilisers for the UK's landscape and regeneration sectors. Furthermore, gate fees are expected to fall in the future, because of increased revenue from the production of electricity.

2.5.11 Agronomic value of digestate

According to the European Compost Network [17], the nutrient value for solid digestion products was about 11.7 Euro/tonne fresh matter and for liquid digestion products 6.7 Euro/tonne fresh matter. These data were valid for 2007 and went up by about 50% from 2005, due to the rising prices for mineral fertilisers. They are largely comparable with the nutrient values of compost.

According to the *German* Quality Assurance Organisation of Compost (BGK), the fertiliser value for digestate (with 5.2 kg N/m^3 fresh matter, 1.6 kg P_2O_5/m^3 fresh matter, 2.3 kg K_2O/m^3 fresh matter and 2.2 kg CaO/m^3 fresh matter) was 6.38 Euro/m^3 fresh matter in April 2011. When including organic matter, the monetary value of digestate is calculated at 7.23 Euro/m^3 fresh matter.

Based on ammonia nitrogen content and phosphorous, digestate with 4% dry matter content is estimated to have an economic value of 4.5 Euro/ton digestate in *Sweden*.

([17]) http://www.compost.it/biblio/2010_beacon_conference_perugia/2nd_day/5.c%20-%20Barth.pdf

2.5.12 Market outlook for digestate

Despite the low sales price for digestate, several Member States cleary experience an increasing trend for digestion and a shift from composting to digestion or to combined composting and digestion. This evolution is explained by the fact that municipalities are able to negotiate lower gate fees to biowaste operators thanks to increased competition in the biowaste treatment sector. Hence biowaste operators are forced to generate revenue through other options, such as through the sale of electricity from biogas production.

In Member States with emerging treatment facilities for biodegradable waste and a large history of landfilling, the market development seems to be less smooth. In the *Czech Republic,* gate fees for landfilling of 30-40 Euro/tonne include 20 Euro/tonne landfill tax that directly goes to the receiving municipality. Because of the latter policy, municipalities tend to largely support landfilling, as it provides a certain income, at the expense of anaerobic digestion. As a result, waste anaerobic digestion plants are orienting themselves towards industrial materials such as glycerine from biodiesel production, with a high biogas yield.

Finally, high value products, such as biothermally dried digestate sells at prices that compete with industrially made fertilizers and could hence become an important source of revenue for digestion plants.

2.6 Standards and technical specifications

This section deals with standards and technical specifications for compost and digestate. It should be noted, however, that standards and legislative aspects are commonly interwoven, as certain member states recognize the efforts of voluntary quality assurance schemes through legislation. Hence, this section and the next section on legislative aspects may contain closely related information.

2.6.1 Compost categories

Compost classifications are very diverse across Member States. The categories are usually defined by compost, fertiliser or soil protection legislation or by voluntary standards. The criteria typically applied for classification are the input materials used, the compost product quality (contents of hazardous substances, nutrients, impurities), and the uses for which the compost is fit. In this report, the categories defined according to input materials are called ‘compost types’ and the categories defined according to product quality are called ‘compost classes’. Table 6 suggests a terminology for the most relevant compost categories. More detailed descriptions of existing compost categories can be found in ORBIT/ECN (2008).

Table 6: Classification of compost.

Source: ORBIT/ECN (2008).

Input material The compost type is defined by the type, origin and characteristics of the source materials used for the production of the compost.	
Biowaste compost	Compost from kitchen and garden waste (from source-separated waste collection). This is the material commonly collected in the commingled collection scheme for food and garden waste (brown bin, 'biobin' system).
Green waste compost	Compost produced from garden and park waste.
VFG compost	Compost from vegetable, fruit and garden waste. This type of compost has been established in Belgium (Flanders) and the Netherlands based on the collection scheme for organic household waste where the collection of meat is excluded.
Biomix compost	Biowaste, green waste, sewage sludge (quite a common system in Italy where sewage sludge is co-composted with source-separated bio and green waste).
Bark compost	Compost produced from bark; usually not mixed with other organic residues but with additives as a nitrogen source.
Manure compost	Compost from solid stable manure or from dewatered (separated) slurry.
Sewage sludge compost	Compost produced from dewatered municipal sewage sludge together with bulking material.
Mixed waste compost	Compost produced from mixed municipal solid waste (only partial or no source separation of the organic waste fraction), which has undergone mechanical separation and biological treatment (MBT).
Stabilised biowaste	Biologically stabilised (composted) organic fraction from mechanical biological treatment of residual waste.
Product quality Compost classes demand certain quality levels as regards the concentration of contaminants (e.g. heavy metals) and macroscopic impurities.	
Heavy metal classes	Compost classes are distinguished by limit values for heavy metals.
Impurity classes	Limits for the contents of macroscopic impurities like plastics, metals and glass. A two-class class system has been suggested, which should distinguish between composts for food production/pasture land and non-food areas.
Uses The use types classify composts for certain areas of application based on defined quality parameters. In some cases, this is linked to product quality classes.	
Compost for organic farming	For the use of biowaste from source-separated organic household waste, limit values for heavy metals have to be respected (Commission Regulation (EC) No 889/2008). There are no such quality criteria for other compost types like green waste compost. Any compost produced from municipal sewage sludge is forbidden in organic farming.

Compost for food production	Restriction of certain heavy metal or impurities related *compost classes* (e.g. Class 2 or B) for use in agricultural or horticultural food and feedstuff production.
Substrate compost for growing media and potting soils	Compost providing specific performance characteristics such as particle size, salt content, stability, plant response, nutrient availability, etc., in order to be successfully used as a constituent in growing media and potting soils.
Mulch compost	Compost of a generally coarse structure (higher portions of wood chips with a maximum particle size up to ca 35 mm) and with fewer demands regarding maturity.
Mature compost	Fully humified compost generally utilised and recommended in all — also sensitive — applications. Identification is done by methods testing the plant response or measuring the biological activity of the compost (e.g. oxygen consumption, CO_2 evolution, self-heating test).
Fresh compost	Partly degraded material that is still in a decomposition process but thermally sanitised (thermophilic phase). It is used for soil improvement and fertilisation on agricultural land. Identification is done by methods testing the plant response or measuring the biological activity of the compost (e.g. oxygen consumption, CO_2 evolution, self-heating test).

2.6.2 Quality assurance systems

About 700 composting plants in the EU operate under a formal quality assurance system. Quality assurance typically comprises the following elements:

- raw material/feedstock type and quality;
- limits for hazardous substances;
- hygiene requirements (sanitisation);
- quality criteria for the valuables (e.g. organic matter);
- external monitoring of the product and the production;
- in-house control at the site for all batches (temperature, pH, salt);
- quality label or a certificate for the product;
- annual external quality certification of the site and its successful operations;
- product specifications for different application areas;
- recommendations for use and application information.

In some cases, quality assurance is purely voluntary, on private initiative, but more often it is required or promoted by legislation or regulatory authorities. Sometimes there are exemptions from certain legal compliance obligations if the compost is quality certified. Annex 8 provides detailed descriptions of the existing compost-specific quality assurance schemes in the EU.

In 2010, the European Compost Network (ECN) has launched a European quality assurance scheme and produced an accompanying quality manual ([18]).

([18]) http://www.compostnetwork.info/index.php?id=116

The ECN-QAS presents an independent quality assurance scheme and includes fundamental requirements for national quality assurance organisations (NQAO) for compost and basic requirements for a European compost standard in the first instance. Besides a positive list for suitable input materials and requirements for process quality also quality criteria for compost are laid down in the scheme.

The European quality assurance scheme includes the following elements:

- The requirements for conformity assessment of national quality assurance organisations (NQAO) to the ECN-QAS.
- Regular assessment of the production in the plants by the national quality assurance organisation (NQAO) by means of process requirements.
- Regular sample taking and analysis of the final product from independent, acknowledged labs and additionally the evaluation of the results by the national quality assurance organisation (NQAO).
- Documentation by the national quality assurance organisation (NQAO) with information about the quality properties of the product, legal requirements, the necessary compost declaration and information about use and application rates according to good practice.
- Awarding of the ECN-QAS Conformity Label to national quality assurance organisations (NQAO).
- Awarding of a quality label for composting plants and compost products by a conformity assessed national quality assurance organisation (NQAO) in respect to ECN-QAS.

The ECN-QAS Quality Manual provides all information and recommendations on all checks that the applicant and the corresponding body (National Quality Assurance Organisation) have to carry out during the utilisation period of the Conformity Label and Quality Label for compost. The Quality Manual includes the requirements for the conformity assessment of national quality assurance organisations and for composting plants.

The Quality Manual is divided in three main parts:

- Part A: *The European Quality Assurance Scheme* describes the general target and structure of the European Quality Assurance Scheme (ECN-QAS).
- Part B: *Quality Assurance Organisations of the ECN-QAS Quality Manual* specifies the ECN requirements to be met by a national quality assurance organisation (NQAO) for composting plants, which are preconditions for the described recognition procedure of an organisation performing quality assurance according to the European Quality Assurance Scheme of ECN e.V..
- Part C: *European Quality Assurance Scheme for Compost of the ECN-QAS Quality Manual* specifies requirements for the operational process management of composting, the selection of input materials and the compost quality. It includes specifications for sampling and testing. It also specifies requirements for product certification and declaration to ensure that the compost products are consistently fit for their intended uses. These essential elements have to be implemented into the quality assurance scheme of the national quality assurance organisation (NQAO).

2.6.3 Standardisation of sampling and analysis

Today, compost sampling and analysis is carried out following national legal provisions and standards, which are not always comparable. However, the European Commission earlier gave a standardisation mandate to CEN for the development of horizontal standards in the field of sludge, biowaste and soil (Mandate M/330). The mandate considers standards on sampling and analytical methods for hygienic and biological parameters as well as inorganic and organic parameters. Consequently, the CEN Technical Board (BT) created a Task Force for 'Horizontal Standards in the fields of sludge, biowaste and soil' (CEN/BT TF 151). On most sampling and analytical topics, the final consultation and validation of the draft standards took place in autumn 2007 ([19]). The work of the former TF 151 is now being finalized by a technical committee, CEN TC 400.

Until horizontal standards elaborated under the guidance of CEN TC400 are formally adopted, testing and sampling may also be carried out in accordance with test methods developed by Technical Committee CEN 223 'Soil improvers and growing media' ([20]).

2.6.4 Standards and specifications for digestate

Standards and specifications for digestate have been elaborated in a number of EU-27 member states. In Germany a quality assurance system exists for digestate which is carried by "GüteGemeinschaft Gärprodukt e.V.(GGG)", a member of the "Bundesgütegemeinschaft Kompost e.V. (BGK)." Also in Belgium, Sweden, and the UK voluntary quality assurance systems exist for digestate. In each system, the quality is assured by checking the observation of the national regulations (animal by-product, biowaste and fertiliser regulations), prescribing positive lists for the feedstock and monitoring the controlling of the process to prove the compliance with the hygienic requirements. This includes measuring and documenting temperature and pH-value in the reactor and hygienisation unit, hydraulic retention time as well as organic and volumetric loading rate. Types and amounts of substrates and additives have to be documented and certain actions are taken to avoid re-contamination and process disturbances. The feedstock has to be clean and source separated. The operation is controlled by plant visits of independent quality managers. The products are regularly (4 -12 times/year) controlled by independent sample takers and by declaration in analysis reports. Additionally, recommendations are given for the correct application according to the fertiliser regulation.

The European Biogas Association summarizes the different standards and specifications The quality criteria and guidelines applied in Germany are denominated as RAL-GZ 245, which differentiates between solid and liquid digestate. In the UK the quality specification for digestates is called BSI PAS 110:2010, while the quality assurance scheme aligned to the specification is called the Biofertiliser Certification Scheme. The Swedish quality assurance is named SPCR 120. In Switzerland quality guidelines exist for solid and liquid digestate. The demands and criteria of the quality assurance for digestate in different countries are listed in Table 7. S

- In the *UK*, digestate can obtain End of Waste status. The Anaerobic Digestate Quality Protocol was launched in September 2009 and is developed by WRAP (Waste &

([19]) http://www.ecn.nl/horizontal/
([20]) Contact: http://www.cenorm.be/cenorm/index.htm

Resources Action Programme) and the Environment Agency in consultation with industry and other regulatory stakeholders. It is applicable in England, Wales and Northern Ireland. The protocol sets out end of waste criteria for the production and use of quality outputs from anaerobic digestion of source-segregated biodegradable waste, not including sewage sludge. Manure is allowed as an input material. Quality outputs from anaerobic digestion include the whole digestate, the separated fibre fraction and the separated liquor. To be Quality Protocol compliant for this material, digestate producers will need to be certified against the BSI PAS110 certification scheme ([21]), which is managed by the Environment Agency. The PAS is a fast track precursor to a potential future British standard.

- Producers and users are not obliged to comply with the Quality Protocol. If they do not, the quality outputs from anaerobic digestion will normally be considered to be waste and waste management controls will apply to their handling, transport and application.
- Input materials may include non-waste biodegradable materials; input materials that fall under the ABPR must be treated according to the conditions set out in this regulation.
- It must be demonstrated that the quality digestate is destined for use in one of the designated market sectors (agriculture, forestry and soil/field-grown horticulture + land restoration where only separated fibre can be used).
- Test parameters, upper limit values and declaration parameters for validation for PAS 110 are listed in Annex A.

- The Biofertiliser Certification Scheme (BCS) is currently the only quality assurance scheme in the UK for quality digestates derived from source-segregated biodegradable input materials. Information about this scheme can be found on the following web site: http://www.biofertiliser.org.uk/. A detailed description is given in Annex C3.

- In *Sweden*, there is a voluntary certification system in place for anaerobic digestate, the SPCR 120([22]). This SPCR is a quality assurance system for both the process and the quality of the end product, digestate. The requirements for the final digestate product according to this QAS are listed in Annex B. However, as in the case of compost guided by SPCR 152 QAS, digestate complying with the SPCR 120 quality label continues to have a waste status. Substrates for certificated digestate should be clean, source separated and easily biodegradable. Sewage sludge is not included in the input materials list, but manure is allowed.

- In *Germany*, the Bundesgütesgemeinschaft Kompost (BGK) is the carrier of the quality label for compost, digestate products and composted sewage sludge. BGK is recognised by RAL, the German Institute for Quality Assurance and Certification, as being the organisation to handle monitoring and controlling of all quality labels in Germany. According to the input materials used, there are two product groups for digestate and two corresponding labels: RAL GZ 245 for digestion products derived from biowaste and RAL GZ 246 for digestion products from renewable energy crops. The allowabale input materials are marked on a positive list (Annex 1 of the German Biowaste

([21]) PAS 110:2010 Specification for whole digestate, separated liquor and separated fibre derived from the anaerobic digestion of source-segregated biodegradable materials
([22]) http://www.avfallsverige.se/fileadmin/uploads/Rapporter/Biologisk/English_summary_of_SPCR_120.pdf

Ordinance) and should be source separated. Sewage sludge is not included in the input materials list, but manure is allowed. Annex C lists the quality criteria for digestate products from biowaste. The RAL GZ 245 is a voluntary scheme, yet the efforts of participants are rewarded by the authorities by exempting member plants from some control requirements which are subject to the waste legislation. By means of that procedure quality assured digestate have a "quasi" product status in Germany. Both for digestate products from biowaste and digestate products from renewable energy crops, two labels can be authorised for liquid (dry matter content <15%) and solid digestate products (dry matter content >15%). The minimum quality criteria for digestate products include valuable ingredients, potentially toxic elements, physical contaminants and the degree of fermentation. The quality criteria for digestate products from renewable energy crops differ only in the case of hygienic requirements. The thermophilic or mesophilic treatment with a temperature of > 37 °C for a dwell time of 20 days is sufficient. Authorisation to use the RAL quality label for digestate products is granted in accordance with the quality and testing regulations, laid down in the BGK-Methodbook for analysing organic fertiliser, soil improver and growing media. Sampling and investigations should be done by an approved external monitoring body.

- In *Ireland*, the Market Development Programme for Waste Resources 2007-2011 has a considerable focus on organics with several deliverables, including the establishment of an industry-based compost standard, the development of a Quality Assurance Scheme so as to support the establishment of a National Compost Quality Standard and the establishment of crop trials so as to demonstrate the farming community the benefits of using compost and digestate within variable agricultural applications. The work to develop a national compost standard was overseen by the National Standards authority of Ireland (NSAI) and has been completed in July 2011 by the publication of the voluntary Irish Standard 441:2011.

- In *Spain*, at national level there are no standards or technical specifications for digestate from biodegradable waste, but digested sewage sludge has to fulfil the quality standards established in the sewage sludge legislation (RD 1310/1990) for its use in agriculture and digested biowaste has to be composted and is subject to the same quality standards as compost (RD 824/2005).

- For the sale of finished biological treatment products such as compost and digestate, different rules apply in *Belgium*, such as at European level, but also at federal and regional levels. At European level, these products are subject to Animal Byproducts Regulation (EC) 1069/2009 and Commission Regulation (EC) 1013/2006. At the federal level, the Royal Decree of 07/01/1998 on the marketing of fertilizers, soil improvers and growing substrates is in force, while at the regional level, the Manure Decree and VLAREA apply in Flanders, and the Sustainable Nitrate Management Plan (from the Water Code) as well as the Waste Decree apply in Wallonia. For digestates and derived materials containing sludges from waste water treatment, the restrictions mentioned in article 7 of the Sludge Directive 86/278/EEC apply.
    - From the point of view that the production of compost should go hand in hand with the reasoned use of compost and digestate, the Flemish Public Waste Agency supported the initiation of VLACO, the Flemish Compost Association, an independent non-profit membership organisation bringing together the stakeholders with activities related to prevention, collection and treatment of

biowaste (OVAM, compost producers, municipalities and inter-municipalities). The two main work domains of VLACO are compost quality assurance and compost marketing. Since its start-up in 1992, VLACO has considered quality as a key issue. VLACO is working according to the principles of independent certification. This procedure is imposed by Decree in the Flemish legislation VLAREA on 13.09.2009. General Regulations are established, so that all conditions be made clear and the companies involved have clearly identified the certification requirements they must meet. A description of the quality assurance system is given in Annex C2.

Regarding sampling, in Flanders, Vlaco assembles information about the quality of the end product by own sample takings. The treatment plants are visited numerous times per year for sampling and analysis. The minimum required number of samples taken by the producer is calculated from the fraction of biowaste and secondary materials in the input of the treatment plant on an annual basis using the following formula:

number of analyses per year = 1 + X/10000
where X= fraction biowaste and secondary materials (tonnes)

For a plant treating 50 000 tonnes per year this means at least 6 analyses per year. The number is always rounded up. The analyses packages are considered by the quality assurance organisation on a case by case basis. If several product types are produced, the formula above has to be used to calculate the necessary number of analyses for each product type, where the partition of input is made per product type. The dates of sampling must be equally divided during the year.

- In Wallonia, quality assurance systems (ISO 14001-EMAS) corresponding to Regulation EC 761/2011 is actually required for digestion and composting plants and is specified in the environmental permit of the plant. There are also maximum concentration levels for heavy metals and organic contaminants. In Wallonia, analysis is required at a frequency of 1 per 1000 tonnes of fresh matter. Sampling must be carried out by a registered laboratory in order to ensure proper representativeness of the material characteristics

- In *Slovenia*, no quality assurance system has been set up for digestate. The quality standards are the same for compost and digestate (Class I or II).

Table 7: Comparison of digestate standards in DE, UK, SE and Switzerland (Source: European Biogas Association)

Characteristic	*Germany (RAL-GZ 245)*	*UK (PAS 110:2010)*	*Sweden (SPCR 120)*	*Switzerland*
Hygienic aspects				
Proof of successful treatment for sanitization	X	X	X	X
If demanded by ABP regulation: treatment with 70°C for 1 hour and particle size of 12 mm	X	X	X	X
minimum temperature during a hydraulic retention time of 24 h	55 (50) °C	based on HACCP plan		53°C
input-output-control	As possible hygienic proof	X		
germinable weeds and sprouting	Max. 2 / liter		X	X
Salmonella	absent in 50 g fresh matter	absent in 25 g fresh matter		X
Additional hygienic parameters for the treatment of animal-by products				
4 of 5 E.Coli samples 1000 CFU / g fresh matter	As possible hygienic proof	X	X	
Impurities				
Maximum 0,5 % dm selection and weighing of impurities (glass, plastics and metals > 2 mm)	X	X	X	X
Laminary impurities	area sum of the selected impurities < 25 cm²/l fm		X	> 0,1 %
Degree of fermentation				
Organic acids (total) ≤ 1.500 mg/l	X			
Volatile Fatty Acids		X		
Residual Biogas Potential		X		
Odour				
Free from annoying odours	X			
Organic Matter				
Minimum 20% (w/w) dm			X	
Minimum 30% (w/w) dm for solid digestate Minimum 40% (w/w) dm for liquid digestate	X			
potentially toxic elements				
Threshold for heavy metals (Pb, Cd, Cr,Ni, Hg) For micro-nutrients Cu and Zn plausible value should not be exceed.	X	X	X	X
Parameter for declaration				
Product type (digestate product liquid or solid)	X	X	X	X
Name and details of customer		X		
Name and details of producer	X	X	X	X
Weight or volume		X	X	X
Date of dispatch		X		
density	X			
Dry matter content	X	X	X	X
Organic matter	X	X	X	X
pH-value	X	X	X	X
Salt content	X			X
Plant nutrients (total) (N, P_2O_5, K_2O, MgO, S)	X	X (MgO, S optional)	X	X
Nitrogen soluble (NH_4-N, NO_3-N)	X	X (only NH4-N)	X	X
Micro-nutrients (according to fertiliser ordinance)	X			
C/N ratio	X			X
Water soluble chloride (CL^-)		X		
Water soluble sodium (Na)		X		
Heavy metals if the thresholds have been exceeded	X	X	X	X
Alkaline effective matter (CaO)	X		X	
References for good practical use	X	X	X	X

2.7 Legislative aspects

2.7.1 Introduction

This section looks at the legal frameworks that have been put in place to ensure the usefulness of compost and digestate and to manage the environmental impacts and risks of compost and digestate production and use.

The previous sections have argued that the use of compost and digestate as a soil improver or organic fertiliser can improve the chemical, physical and biological properties of soil and lead to better agronomic performance as well as to positive environmental impacts. The use of compost as a component of growing media can reduce the dependence on peat to some extent. Diverting biodegradable waste from landfills to produce compost or digestate reduces the climate change impacts of waste management.

At the same time there are, however, substantial environmental and health risks associated with the production and use of compost and digestate.

Regulators are thus faced with the challenge to optimise the benefits of recycling organic matter and nutrients through composting, and to avoid unnecessary barriers. At the same time the health and environmental impacts and risks need to be managed to ensure adequate levels of safety and environmental protection.

The analysis below pays particular attention to those aspects that are linked to the question of whether composts are a waste or not. It looks at the current national approaches in determining the waste status of compost; systems of compost registration or certification; compost categories; regulation placed on and standards of input materials, product quality and compost use; health protection; quality assurance schemes; standardisation of compost testing.

Legislative aspects for digestate are discussed at the end of the section.

2.7.2 Current approaches to determining the waste status of compost

Today, Member States follow different approaches when determining the status of compost, i.e. whether it is considered a waste or not. In some cases, there are explicit and detailed rules set by legislation under waste law. In other cases, it is mainly up to the discretion of the regulatory authorities to decide. In a third group of countries, there is an implicit assumption that compost ceases to be waste when registered as a product (e.g. as fertiliser).

<u>End-of-waste defined by national regulations under waste law or other national environmental regulations</u>

In some Member States, there is legislation under waste law that explicitly defines the conditions under which compost ceases to be waste. Examples are the Austrian Compost Ordinance ([23]) and the German Biowaste Ordinance ([24]).

The conditions included in the Austrian Ordinance for compost to be considered as a product and not a waste includes:

- a positive list of wastes from which the compost may be produced;
- specifications of the product quality (heavy metal threshold values);
- temperature-time profile during composting to achieve hygienic safety;
- labelling provisions;
- quality control provisions on the input materials and the product;
- external quality control provisions;
- mandatory record keeping (for five years) of batch-wise information on input materials and products, including details of who receives the compost;
- obligations for registering and notifying the authorities;
- analytical methods.

The German Ordinance explicitly states that compost is considered waste until it has been applied to soil (in the case of agricultural use). However, the waste law-based regulatory controls are reduced considerably if a quality assurance system is applied. End-of-waste is not explicitly defined by German regulations when using compost for the production of growing media.

In France, the product quality requirements for compost produced from MSW are defined by the French standard NF U44-051. This standard has been made statutory by the French government. The standard includes thresholds for concentrations of heavy metals and some organic compounds as well as microbiological and agronomic parameters. Compost that complies with the requirements of the standard is considered a product (and not a waste).

<u>End-of-waste determined by regulatory authorities, possibly on the basis of acknowledged protocols and standards</u>

This is the case, for example, in the United Kingdom (England and Wales).

In England and Wales, compost must be sold/supplied in accordance with the Environmental Permitting (England and Wales) Regulations rules for the storing and spreading of compost on land. There are no explicit quality criteria, but on the registration form and from the evidence (test results for the waste) sent to the regulator, the 'agricultural benefit' or 'ecological improvement' must be justified. The regulator then makes an evaluation taking account of the characteristics of the soil/land that is intended to receive the waste, the intended application rate and any other relevant issues.

([23]) Verordnung des Bundesministers für Land- und Forstwirtschaft, Umwelt und Wasserwirtschaft über Qualitätsanforderungen an Komposte aus Abfällen (Kompostverordung). BGBl. II — Ausgegeben am 14 August 2001 — No 292.

([24]) Verordnung über die Verwertung von Bioabfällen auf landwirtschaftlich, forstwirtschaftlich und gärtnerisch genutzten Boeden. BGBl. I 1998 S. 2955, BGBl. I 2001 S. 1488.

The recently agreed Quality Compost Protocol (QCP) represents the thinking of the Environment Agency for England and Wales as the reference for defining the point at which compost may become a product. It sets the criteria for production of quality compost from source-segregated biodegradable waste. Quality compost will normally be regarded as having ceased to be a waste when dispatched to the customer.

<u>De facto end-of-waste when registered as fertiliser</u>

In many countries, compost has to be registered under fertiliser regulations (e.g. as an organic fertiliser or as a soil improver) before it can be used in agriculture. It is then implicitly assumed that registered compost is a product and has ceased to be waste. This situation can be found in the Czech Republic, Greece, Spain, Italy, Latvia, Hungary, the Netherlands, Poland, Portugal, Slovenia and Finland.

Finally, there is a group of countries where compost production is not common, compost-specific regulations do not exist and the waste status of compost is not yet an issue.

More details on how the waste status of compost is determined today in each Member State are presented in Annex 2-2.

2.7.3 Systems of compost registration or certification

Usually it is required by the corresponding regulation that compost must be registered or certified before it can be used or placed on the market. Sometimes, but not always, such registration or certification implies end-of-waste.

In practice, there are three main legal bases under which compost is certified or registered:

- fertiliser legislation, with and without specific compost provisions;
- waste legislation, with specific compost or biowaste ordinances or under general waste treatment licensing procedures;
- soil protection legislation, with minimum requirements for waste derived materials, sludge and compost to be spread on land.

Standards or voluntary agreements based on criteria which are implemented by quality assurance schemes are another category, however, without direct legal status.

Following ORBIT/ECN (2008), one may distinguish four typical compost registration or certification schemes.

1. Simple registration systems without third-party verification

The main criterion of registration is final compost quality and product declaration (e.g. as an organic fertiliser or an organic soil improver). Sampling is done directly by the compost producer. External quality control is not systematic. Inspections by regulatory authorities are possible but typically not frequent. Usually, once registered, the compost can be traded as a product without further waste regulatory controls, even if formal end-of-waste is not established explicitly. According to ORBIT, this scheme can be found in the Czech Republic, Ireland, Spain (certain regions), France, Latvia, Hungary, the Netherlands and Poland.

2. Simple registration systems with third-party verification

Testing of compost quality is carried out by an external laboratory that is acknowledged by the authorities. The laboratory may also certify compliance with a wider set of legal requirements concerning the documentation, the process management and the input materials used. This system can be found in Spain (certain regions), Denmark and Slovakia.

3. Third-party product certification under specific compost legislation

This means full-scale product certification schemes, such as under the Austrian Compost Ordinance. Such schemes include the following elements:

- the compost producer is responsible for the compliance with all requirements for input materials, process management and documentation, external quality approval and product declaration;
- the compost producer must have a contract with an authorised laboratory;
- sampling is done by the authorised laboratory or a contracted partner of the laboratory;
- the authorised laboratory and/or a quality assurance organisation (QAO) inspect and approve the required documentation and the required quality and process management in compliance with all legislative provisions;
- based on the analytical and the on-site inspection report, the authorised laboratory or the QAO awards a product and plant operation certificate including (in most cases) the permission for the use of a quality label;
- in some cases, the compost then obtains the product status from the moment a compost batch is declared compliant according to the certificate provided by the external laboratory or QAO;
- based on the certified product labelling and declaration including recommendations for proper use in the foreseen applications and market sectors, the correct application in line with all further soil and environment related rules is entirely the responsibility of the user.

Schemes of this type exist in Belgium (Flanders), Germany, Luxembourg, the Netherlands, Austria and Sweden. Membership of a quality assurance organisation is, in most cases, voluntary, although often promoted by authorities or legal incentives. In Belgium (Flanders), the entire external certification and quality assurance system is executed by a semi-public organisation and it is obligatory for all compost producers to participate.

4. Third-party certification including the use of compost

In the United Kingdom, the Quality Protocol (QCP) issued by the Environment Agency and the Waste & Resources and Action Programme (WRAP and Environment Agency, 2007) has established a comprehensive quality assurance scheme which requires extensive documentation and record keeping from the compost producer. The QCP also contains requirements for accreditation and auditing by the sector. In this respect, the concept is similar to the scheme described above. It is different, however, in that it also requires compost use documentation in agriculture and soil-grown horticulture to be kept by the land manager and made available to the compost producer and the certification body.

2.7.4 Regulations and standards on input materials

Most national regulations dealing with compost include restrictions on the input materials that may be used for compost production. In most cases, there are ‘positive lists’ of the allowed types of input materials. Materials not included on the list are forbidden as inputs. The most sensitive questions regarding input materials are whether municipal sewage sludge is allowed and in what form the biological fractions of MSW may be used as an input (whether there is a requirement for source segregation or not).

Most positive lists follow the classification of the European Waste Catalogue, and in some cases, include some additional specifications or requirements. If the waste list is directly binding, the system is rather rigid. This has been addressed, for example, in the case of Belgium, by allowing case-by-case decisions to be made by the competent authorities, based on a more generic positive list.

Usually, national regulations require that composting plants are run with a consistent control of the input material (compliance check upon receiving the waste), which includes documentation to ensure traceability and allows inspection by the competent authorities.

Annex 9 presents a comparative list and classification of the waste materials that are allowed for the production of compost in EU Member States.

2.7.5 Regulations and standards on product quality

Compost-related national regulations as well as compost quality certification schemes usually include minimum product quality requirements for ensuring the usefulness of compost and for achieving the desired levels of health and environment protection. Minimum product quality requirements typically demand that composts should:

- have a minimum organic matter content, to ensure basic usefulness and to prevent dilution with inorganic materials, as well as sufficient stability/maturity;
- not contain certain pathogens (such as salmonellae) that pose health risks;
- contain only a limited amount of macroscopic impurities (as a basic requirement for usefulness and to limit the risks of injuries);
- only have limited concentrations of pollutants (mainly regarding heavy metals and sometimes also certain types of organic pollutants).

Further requirements are often included as specifications for certain uses and application areas. For instance, there are a number of compost standards and specifications for using compost in growing media and potting soil or for use in landscaping. Examples are the RHP quality mark for compost substrate components for horticulture and consumer use, or the RAL Quality label for compost with requirements for compost for potting soils/growing media (RAL, 2007) (see also Section 2.4.2).

In addition to requiring that limit values for the mentioned parameters are met, it is usually also required that the values for these parameters and further properties, such as salinity or electric conductivity, are declared (without the need for complying with limits). The purpose is to inform the potential users of the compost about the material properties.

Legal limits on heavy metal concentrations are in place everywhere that compost plays a role today. Limits are usually set at a national level and differ from country to country. In some countries, limits have been set for a number of different compost classes. At the EU level, a set of heavy metal concentration limits exists as part of the EU eco-label criteria for soil improvers and growing media. Another set of limits applies to the use of certain composts in organic agriculture. Annex 3 provides an overview of the heavy metal concentration limits for compost in the EU.

In most places, limits also exist for macroscopic impurities. Sometimes a maximum concentration is set for the sum of plastics, metals and glass particles with a particle size of > 2 to 5 mm or there may be more complex regulations with separate limits for different types of impurities and considering more than one particle size (e.g. 2 and 20 mm fraction for plastic constituents).

Annex 4 shows examples of the impurity limits included in national regulations and standards.

The rules for compliance testing (number of tests, protocols for sampling, analysis) are also different across Member States. Efforts to produce European harmonised standards are ongoing (see also Section 2.6.3.).

2.7.6 Health-related requirements

Provisions for the exclusion of potential pathogenic micro-organisms are established on two levels:

- direct methods by setting minimum requirements for pathogenic indicator organisms in the final product;
- indirect methods by the documentation and recording of the process showing compliance with required process parameters (HACCP concepts, temperature regime, black and white zone separation, hygienisation/sanitisation in closed reactors, etc.).

Annex 5 gives an overview of national regulations with respect to indirect and direct methods as well as of the requirements of the EU Eco-labels on soil improvers and growing media and of the Animal By-products Regulations. It also shows the requirements and limit values for germinating weeds and plant propagules.

At the European level, a key reference is the Animal By-products Regulation (ABPR) ([25]), which provides detailed hygienisation rules for composting and biogas plants which treat animal by-products.

([25]) Regulation (EC) No 1069/2009 of the European Parliament and of the Council of 21 October 2009 laying down health rules as regards animal by-products and derived products not intended for human consumption and repealing Regulation (EC) No 1774/2002 (OJ L 300, 14.11.2009, p. 1-33).

The ABPR restricts the types of animal by-products that may be transformed in a biogas or composting plant. Materials that are allowed under certain conditions include amongst others:

- manure and digestive tract content;
- animal parts fit for human consumption (not intended for human consumption because of commercial reasons);
- animal parts rejected as unfit for human consumption (without any signs of transmissible diseases) and derived from carcasses fit for human consumption;
- blood, hides and skins, hooves, feathers, wool, horns, hair and fur (without any signs of diseases communicable through them);
- former foodstuffs and waste from the food industry containing animal products;
- raw milk;
- shells, hatchery by-products and cracked egg by-products;
- fish or other sea animals (except sea mammals);
- fresh fish by-products derived from the food industry.

The hygienisation requirements are laid down in the Implementing Regulation (EC) 142/2011, ([26]), which entered into force on 4 March 2011. Amongst other requirements, this states that Category 3 materials (which include, for example, catering waste) used as raw material in a composting plant must comply with the following minimum requirements:

- maximum particle size before entering the composting reactor: 12 mm;
- minimum temperature in all material in the reactor: 70 °C;
- minimum time in the reactor at 70 °C (all material): 60 minutes.

As an alternative to the time-temperature regime of 70 °C for one hour at a particle size of 12 mm, the possibility of a process validation system to be conducted by Member States was introduced. The authorisation of other standardised process parameters is bound to the applicant's demonstration that such parameters ensure the minimising of biological risks.

The ABPR also requires control of the final product. This is divided into two measures:

- representative sampling during or immediately after processing in order to monitor the proper functioning of the hygienisation process, and
- representative sampling during or on withdrawal from storage in order to approve the overall hygiene status of the product.

Escherichia coli or enterococcae are used as indicators for the hygienisation process. The hygiene status of the product is tested with *Salmonella*, which must be absent in 25 g of the product. It is up to the competent authority to decide on sampling schemes (i.e. considering the total throughput and the maximum time span between two sampling dates).

([26]) Commission Regulation (EU) No 142/2011 of 25 February 2011 implementing Regulation (EC) No 1069/2009 of the European Parliament and of the Council laying down health rules as regards animal by-products and derived products not intended for human consumption and implementing Council Directive 97/78/EC as regards certain samples and items exempt from veterinary checks at the border under that Directive.

There are possible exceptions for catering waste ([27]), which may be processed in accordance with national law unless the Commission determines harmonised measures.

According to Article 32 of Regulation (EC) No 1069/2009, organic fertilisers (compost and residua of biogas production) shall be under strict control until final use of such material.

In summary, it can be stated that compost and digestate containing animal by-products will always be subject to the specific provisions of Regulation (EC) No 1069/2009 with regard to hygienisation, transport, use, etc. No national or EU wide End of Waste regulations established for such materials can overrule or annul Regulation (EC) No 1069/2009.

2.7.7 Regulations of compost use

The regulations and standards for compost use vary considerably across countries. There are countries where compost use is subject to a complex network of regulations on national and/or provincial level (Germany, the Netherlands, Austria) and then there are countries where compost can be used without any legal directions (Greece, Portugal, Slovenia).

Use rules include direct regulations like dosage restrictions (admitted quantity of compost per hectare) and indirect rules such as good agricultural practice (GAP) protocols and cross-compliance requirements in agricultural application. The latter refer mainly to fertilising, which should be executed in a way that considers the nutrients in soil and in compost as well as the uptake by the plant and to manage organic matter with the target to keep soils in a proper condition

The main restrictions in EU countries usually concern the permissible quantity of compost (tonnes dry matter) at a maximum heavy metal content (compost class) which can be spread annually, or over two to five years. Annex 6 provides an overview of the restrictions in place.

The following systems of application rules can be distinguished:

- direct load limitation (grams of substance per hectare and year), in most cases calculated on a basis of 2 to 10 years;
- restrictions of the admissible dosage of dry matter compost per hectare and year;
- restrictions according to a maximum nutrient supply (phosphorus and/or nitrogen) to the agricultural crops.

The restrictions are usually intended to regulate continuous applications, as in agriculture. In most other applications, e.g. landscaping, compost is applied only once or infrequently. Here, larger amounts (e.g. 200 tonnes dry matter in 10 years) are used to achieve the desired application effects.

In some cases, the factor which limits application rates is not only the heavy metals but the nutrient contents, especially phosphorus and nitrogen.

([27]) Catering waste means all waste food including used cooking oil originating in restaurants, catering facilities and kitchens, including central kitchens and household kitchens.

The ranges of restrictions for the amounts of compost (on a dry matter basis per hectare) or plant nutrients to be applied can be summarised as follows:

• quantity of compost (*)	agriculture/regular	3 (pasture)–15 (arable) tonnes/ha/year
	non-food/regular	6.6–15 tonnes/ha/year
	non-food/once	100–400 tonnes/ha
• quantity of N	agriculture/regular	150–250 kg/ha/year
• quantity of P_2O_5	agriculture/regular	22–80 kg/ha/year
	set aside land	20 kg/ha/year

(ha = hectare)

(*) In most cases quantity differentiation depends on quality class obtained.

More details, country by country, are provided in Annex 6.

In many cases, the need to comply with the EU Nitrates Directive or national water protection legislation has led to maximum application regimes for nitrogen or forbidding the application of compost during the winter season. This is justified by the fact that there is no nutrient uptake in winter time, so there is a risk that all nutrients are washed out as runoff to the water bodies.

Finally, it becomes more and more common to consider the application of compost in fertiliser management systems. Germany for example refers to the need to follow ‘best fertilising expert practise’, whilst in the Netherlands there is a system of three application standards per hectare and year (total N from fertilisers, total P from fertilisers and total N from animal manure).

2.7.8 Legislative aspects for digestate

Most member states generally regulate the quality and application of digestate and other biowastes through waste laws (e.g. DK) or fertiliser legislation (e.g NL), which are similar or identical to the data described above for composts.

In the UK, digestate can receive end of waste status through the Quality Protocol. Also the Czech Republic provides product status for digestate via national regulation: biodegradable waste treatment decree (341/2008 Sb.) or fertilizer law (156/1998 Sb.).

On a European level, the Animal By-Products Regulation also applies to anaerobic digestion facilities.

- *England, Wales and Northern Ireland* have adopted the ‘Quality Protocol for the production and use of quality outputs from the anaerobic digestion of source-separated biodegradable waste’ (AD QP). This document defines the full recovery for digestates, namely the point at which digestates cease to be waste and can be used as a product, without the need for waste management controls. More information is provided in Annex C4.

- In *Germany* there is no specific legislation only for digestate. Legal requirements for digestate are included in waste legislation as well as in the legislation on fertilisers. Waste legislation regulates “bio-waste”, which is not identical to the European definition, as it includes a number of biodegradable waste streams apart from kitchen and green waste suited for later use on soil. These waste streams are listed in the Ordinance on the Utilisation of Biowastes on Land used for Agricultural, Silvicultural and Horticultural Purposes. The ordinance applies to any treatment, treatment meaning any controlled degradation of bio-waste under aerobic conditions (composting) or anaerobic conditions (fermentation) or any other measures for sanitisation suitable for the biodegradable waste listed in the bio-waste ordinance. All quality requirements, i.e. limit values for pollutants or standards for pathogen reduction, for bio-waste apply. Detailed specifications concerning specific waste streams or treatment methods can be found in the ordinance as well. Voluntary quality assurance systems are structured along the same lines and from the legal point of view are valid for compost and digestate irrespective of the fact whether digestate has been composted following anaerobic treatment or is liquid or solid. Next to the obligatory legal parameters a Quality Assurance (QA) system can of course include additional parameters for specific outputs, i.e. the BGK RAL QA system includes the "degree of digestion" in the form of organic acids that must be lower than 1500 mg/l for liquid digestate but not for compost. Furthermore, additives are regulated in the Fertilizer Ordinance and used only in low concentrations in anaerobic digestion. The aim is to stabilize and optimize the anaerobic process or avoid the formation of hydrogen sulphide. Non-composted digestate is used frequently as a fertiliser in Germany and in addition to waste legislation must fulfil the requirements of legislation on the use of fertilisers.

- The *Netherlands* have no specific end of waste legislation for biowaste, nor for digestate. However, within the Dutch Fertiliser Act there are provisions for different types of biowaste which can be allowed as a fertiliser on agricultural land. The effect is similar to having an EoW status. A distinction is made between compost, sewage sludge and other biowaste from the food/feed/fuel -process industry. For each group of these fertilizers only one class of quality criteria is available in the Fertilizer act. Furthermore, there is no specific registration system in place for digestate. Regulating the input side is generally not used. It is for the operator to ensure that his product meets the quality criteria on the output side. In general, for separately collected biowaste this is no problem, but the Dutch experience with digestate from mixed waste is that such material can not meet the output criteria. The Dutch Ministry of Environment and Infrastructure also mentions that an associated problem is the fact that mixed waste may contain all sorts of pollutants, which can and will in practice not all be monitored. According to them, this increases the risk that also the end product contains unknown (non monitored) pollutants in concentrations likely to endanger the environment or human health. They argue that for separately collected material this risk is not significant. For the use of digestate on soils, the same requirements apply as for compost from aerobic treatment of biodegradable waste.

- In *Spain*, no specific legislation regarding digestate from biodegradable waste exists. However various parts of existing legislation are also applicable to digestate: digested sludge is subject to legislation on sewage sludge and digested source-separated biowaste or digested organic matter from mixed municipal waste (usually composted) is subject to legislation on compost. In Catalonia there is also a technical instruction according to which sewage sludge that is not suitable for direct application in agriculture is also prohibited as input material in co-digestion plants to be co-digested with manures or slurries, an analysis of digestate and soil is required prior to the agricultural spreading of digestate when this digestate comes from co-digestion plants and digestate from biowaste has to be composted and can be used in agriculture but digestate from mixed municipal waste has to be stabilised and can not be used in agriculture.

- In *Estonia*, the use of sewage sludge in agriculture is heavily regulated. If the inputs for anaerobic digestion are manure and slurry, the quality and use does not fall under the Jäätmeseaduse (Waste Act) regulation, but under the Väetiseseaduse (Fertilizer Act) and Veeseaduse (Water Act) regulation. In the case of sewage sludge, the quality standards are currently based on the Water Act through the regulation of sewage sludge.

- In *Slovenia*, at present, digestate is covered by the Decree on the treatment of biodegradable waste (Official Gazette of the Republic of Slovenia, no. 62/2008). The annex 1 to this Decree provides a list of biowaste suitable for biological treatment. In case of production of compost or digestate, the producer has to put in place the necessary controls on the incoming biowaste to ensure that there is no intentional dilution of polluting substances.

- In *Austria*, the same positive list of input materials applicable for compost also applies for the treatment in biogas plants if the material is suitable for digestion. The list is based on the principle of separate collection and the use of clean and traceable organic sources. Furthermore, Austria has a Guideline on the use of digestate on agricultural land.

2.8 Environmental and health issues

2.8.1 Environmental and health issues of compost

2.8.1.1 Introduction

Quite independently of the composting technique applied and the nature of the input materials, composting has a series of potential environmental interventions and health issues associated to it. They are presented in this section and include greenhouse gas and other air emissions, water emissions (leachate), soil related effects, hygiene issues and the risk of injuries, and positive environmental effects of compost use. Finally, conclusions are made with the regard to the main issues.

The fact that the potential environmental and health impacts of composting are discussed in a comprehensive manner should not be misinterpreted as an indication per se of compost being good or bad for the environment. The purpose of this chapter is simply to provide the information base for understanding the potential environmental and health impacts and risks that need to be managed. Such a comprehensive analysis is required for any material that is a potential candidate for end-of-waste criteria.

2.8.1.2 Air emissions

Gaseous emissions from the composting process include carbon dioxide (CO_2), water vapour, and, in smaller quantities ammonia, (NH_3), volatile organic compounds (VOCs), bioaerosols (fungi, bacteria, actinomycetes, endotoxins, mycotoxins) and particulates. Usually there will also be methane (CH_4) emissions, as it is often not possible to guarantee that all material will be kept under aerobic conditions at all times. Depending on the input materials, composting may release odour emissions, which can potentially be strong.

In closed composting systems, biofilters are often used to treat the waste gas to reduce the emissions of odours, some VOCs, ammonia, aerosols and particulates. On the other hand, certain emissions may also be increased by biofilters, in particular N_2O.

According to ADEME (2005) and DEFRA (2004), there is a lack of generally representative quantitative air emission data.

The DEFRA study carried out a ‘Review of environmental and health effects of waste management: municipal solid waste’. It was based on a substantial sample of the available literature and data. The study systematically assessed the reliability of all the data, taking into account, for instance, the number of waste management facilities from which data were available, if an extrapolation to the full sector at a national level was possible, and whether the information came from peer reviewed literature, was endorsed by governmental bodies, or came from ‘grey’ literature. The study report as such underwent an external review by the Royal Society. The study concluded that the available data were not sufficient to quantify air emissions from composting, mechanical biological treatment (MBT) or anaerobic treatment.

The ADEME report, which systematically establishes emissions data for biological treatments based on a reliability assessment of data found in literature, comes to similar conclusions, and confirms that there is a general lack of representative air emissions data (and, in the case of compost, especially VOCs). It also notes a general lack of data on emissions during the storage of the biological material.

In recent years, several new investigations on gaseous emissions from composting, covering various composting techniques, have, nevertheless, been carried out and used to characterise the state of the art of composting (Amlinger et al., 2005; Cuhls and Mähl, 2008).

The CH_4 and N_2O emissions are important for the climate change impacts of composting (see Section 2.8.1.3 on greenhouse gas emissions) while the CO_2 emissions are considered climate-neutral because they originate mainly from short-cycle biomass (see also next section on greenhouse gas emissions).

The other emissions are relevant mainly for potential occupational and local population health impacts or may be perceived to be a nuisance. They make it necessary to take suitable measures to protect plant workers and residents in the surrounding areas.

Workers at a composting facility may be exposed to, and inhale, large quantities of bioaerosols if not protected by technical or operational means. It needs to be considered that there are certain individuals, for example asthmatics and the immuno-compromised, that are especially susceptible to potential adverse health effects after exposure to bioaerosols.

2.8.1.3 Greenhouse gas emissions

The fate of the organic carbon contained in the waste is one of the key factors that determine the relevance of compost production and use for climate change, i.e. the extent to which the carbon is immobilised or degraded and emitted as gas, and the proportions of CO_2 and CH_4 in the gas emissions. A second important factor is N_2O emissions during composting. Other greenhouse emissions are, in most cases, of much less relevance (including those originating from process energy or transport).

According to the Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories, CO_2 from organic waste handling and decay should not be included in greenhouse gas inventories. The reason is that organic material derived from biomass sources which are regrown on an annual basis is the primary source of CO_2 released from such waste. These CO_2 emissions are not treated as net emissions from waste according to the IPCC guidelines (if biomass raw materials are not being produced sustainably, the net CO_2 release should be calculated and reported under agriculture, land use change or forestry).

However, consideration needs to be given to the fact that if organic waste or materials obtained from biomass remain at least partly un-degraded for longer times, this effectively removes carbon from the atmosphere. This is the case, for example, when compost that has been spread on agricultural land is only slowly mineralised and increases the soil organic matter, or when organic material in landfills decays only over many years.

Composting, as an aerobic biological degradation process, degrades the carbon of the input materials mainly into CO_2. The percentage of the carbon content that is converted depends partly on the nature of the input material. In the case of kitchen waste, composting converts about two thirds of the carbon content of the input material into CO_2. This means that about 0.9 kg CO_2 is generated per kg dry matter of the biowaste input. In the case of green waste, this value is much lower at about 0.17 kg CO_2/kg dry matter (ADEME, 2005). Data from the European Compost Network indicate a CO_2 release of 0.35 to 1.2 kg CO_2/kg dry matter. It is noticed that the CO_2 released is neutral to climate change as it has been taken up from the atmosphere during the lifetime of the organisms.

After the composting process is finished and when compost is used, for example, as a soil improver, the remaining organic matter in the compost is then relatively stable and further degradation is rather slow. This depends on the physical, chemical and biological environment in which the compost is used. The further release of carbon to the atmosphere is therefore only gradual. Relatively little is known about the rates of transformation, which vary depending on climate and soil type. It has been estimated that, on average, some 13 % of the organic carbon supplied by the application of compost remains in the soil after 50 years (Eunomia, 2002; Annex p. 95). Assuming that the composting process had reduced the original organic carbon content by 50 % (for example of a mixture of green waste and kitchen waste), this means that about 6.5 % is still not degraded after 50 years. Furthermore, if compost use enhances biomass production, this may bind further carbon from the atmosphere in addition to the direct carbon input by the compost.

If compost displaces other fertilisers, this may lead to greenhouse gas emissions being saved by the avoidance of fertiliser production. If it displaces peat as a soil improver or in growing media, then this avoids the long-cycle carbon emissions emanating from the degradation of peat under aerobic conditions. According to a report from the Dutch Waste Management Association([28]), transport of vegetable, garden and fruit waste causes about 0.010 kg CO_2-equivalents emissions per kg input material, compared to savings of 0.113 kg CO_2-equivalents per tonne input material by use of the resulting compost in a mixed use scenario (agriculture, greenhouses, growing media and other peat and fertilizer replacements).

In theory, composting as an aerobic process should not generate CH_4. In practice, however, and depending on the type of composting process and its management, the oxygen supply and the aerobic conditions during the biological degradation are not perfect. The lack of oxygen may then lead to anaerobic processes and to emissions of CH_4. The proportion of the carbon content of the input material that is transformed into CH_4 emissions varies widely, depending on the type of input materials and the processes, but can be from 0.01 % to 2.4 % of the original carbon according to ADEME (2005). A typical value found for CH_4 emissions from household waste composting would be 0.04 kg CO_2-eq./kg of dry matter of the input material. The European Compost Network suggests greenhouse gas emissions for CH_4 and N_2O to be in the range of 0.03 to 0.07 kg CO_2-eq/kg fresh matter or 0.09 to 0.2 kg CO_2-eq/kg dry matter, based on Amlinger et al. (2008) (obtained from data of different type of composting and different types of input materials). According to ECN, if compost is well matured then even in piles of matured compost CH_4 emissions will be close to zero, whereas half rotted and active stocked material would produce still considerable greenhouse gas emissions. Therefore, in principle, at least in case of mature compost, if incorporated to soil at usual amounts of 0.4 to 0.5 % of a 20 cm soil layer the likelihood of producing higher CH_4 emissions than naturally emitted by the soil is extremely low.

Sometimes organic waste composting is preceded intentionally by a phase of initial anaerobic degradation to reduce odours, for example. If the generated gas is not captured adequately, this will lead to CH_4 emissions to the atmosphere. The CH_4 emissions of such intentional anaerobic pretreatment seem potentially important but have not yet been investigated.

It is quite likely that the application of compost onto agricultural land is neutral in terms of CH_4 emissions; however, this has not yet been scientifically confirmed. There is a lack of literature and measured data on how the use of compost on agricultural land influences the flows of CH_4 between the soil and the atmosphere (ADEME, 2005).

N_2O is generated directly by the composting processes (quantities are strongly influenced by the C/N ratio) but also in biofilters, which are sometimes used to clean the composting exhaust gas stream from other components (see for example Cuhls and Mähl, 2008). For the composting of biowaste, the N_2O emissions have been found to be in the range 0.002–0.05 kg CO_2-eq./kg of input dry matter (typical value: 0.02 kg CO_2-eq.). For household waste, the range is 0.005 to 0.125 kg CO_2-eq./kg of input dry matter (typical value 0.1 kg CO_2-eq.) (ADEME, 2005). The European Compost Network has also reported numbers within this range.

The use of compost as an organic fertiliser may, to some extent, reduce the N_2O emissions associated with the use of mineral nitrogen fertilisers. However, this effect has not been quantified reliably so far.

Generally, the figures on greenhouse gas emissions other than CO_2 (i.e. CH_4 and N_2O) are based on a limited number of measurements, which are not fully representative.

([28]) Vereniging Afvalbedrijven (2010) Milieuverslag GFT-afval 2009, 34 p.

According to information from the European Compost Network, emissions generated during composting contribute for 0.01 to 0.06% to the national greenhouse gas inventories for the EU.

2.8.1.4 Leachate

Some composting systems recirculate leachate, whilst others treat the liquid residue if required or discharge it directly into the sewerage system. Often composting requires a net input of water because of evaporation during the composting process. In well-managed composting processes impacts on the environment can be assumed to be negligible. However, there is no consolidated information on the amounts and compositions of leachate released that considers the variety of composting plants in operation.

2.8.1.5 Soil-related issues

The application of compost to soil changes the soil's chemical, physical and biological properties. The parameters affected include: contents and availability of plant nutrients, soil organic matter, pH, ion exchange capacity, chelating ability, buffering capacity, density, structure, water management, biodiversity and biological activity. Composts become part of the soil humus and have long-term effects on soil properties. The ways in which compost can affect soil are very complex and far from being fully understood; however, it is widely accepted that compost will have a positive long-term effect on soil fertility if the quality of the compost used is assured and good agricultural practice is followed.

At the same time, the use of compost on soil as an organic fertiliser or soil improver has diverse environmental implications. If composts are applied to land, the chemical content of the composts is transferred to the soil. For potential negative effects, heavy metals and organic pollutants especially need to be considered.

The contents of heavy metals in composts are generally well studied and controlled in compost applications. They are determined by the materials entering the composting process as inputs. Apart from a natural enrichment of heavy metals due to water and organic matter losses, the composting process itself has little impact on the heavy metal content. Annex D lists 7 heavy metal contents at median and 95 percentile levels for a series of composts, digestates and sewage sludges, based on input received following the stakeholder survey of December 2010. The data clearly indicate that the used technological approach generally has a large influence on heavy metal content, as e.g. shown from the difference in heavy metal content for French composts derived from either source separation or MBT. At the same time, large quality variations are encountered for composts based on the same technology, as is illustrated by the Cu levels in composts of Dutch VFG compost versus Spanish composts from source separated materials. Such differences may partly be attributed to different background soil heavy metal contents or agricultural practices (e.g. use of $CuSO_4$ as a fungicide), but are also influenced by the quality of source separation. Finally, lower levels of heavy metals in MBT composts obtained in more recent times in France compared to the metal levels in compost from Spanish MBT plants longer ago suggests that technological advancement offers possibilities for quality improvement. This illustrates that the use of a certain technology in itself does not constitute a sufficient guarantee or insurmountable hurdle for compost quality and that monitoring of input materials, processes and product quality is of utmost importance.

Heavy metals may be directly toxic to plants or passed through the food chain to humans. The fate of the heavy metals in soil is very site specific and depends on a number of factors such as the nature of the crop and the type and pH of the soil. Repeated applications of compost to soil generally lead to an accumulation of heavy metals, for which the long-term impact may be unknown. However, a more recent review of existing scientific literature (Smith, 2009) states that only positive effects of compost application on the microbial status and fertility of soil have been reported. Nonetheless, there are important local variations concerning the accumulation of heavy metals (background concentrations are generally increasing), their leachability into groundwater, and the uptake of heavy metals by plants and consequences once in the food chain. Some metals such as zinc, copper and nickel are vital trace elements for plant growth as long as their quantity is not too high.

Relatively little is still known about the contents, fate and effects of organic pollutants in compost. Organic pollutants may be introduced into the compost through the input materials and, to some extent, may also be generated during the composting processes. At the same time, there is also degradation of organic pollutants. Persistent organic pollutants (POPs), however, are hardly removed by composting. It has been shown, for example, that some poly-aromatic hydrocarbons (PAHs) are hardly degraded during composting and are ecotoxicologically relevant when transferred with compost to soil (Kupper et al., 2006).

Field experiments showed, for the investigated quality assured composts in Germany, that regular applications did not lead to an accumulation of organic pollutants in soil (including PCB ([29]), PCDD/F ([30]) and PAH) (Kluge et al. 2008).

Generally, there is considerable uncertainty about the exact nature and size of the impacts and risks when compost is spread on soil, especially if no suitable compost quality assurance is applied. The reasons include the variability of the input materials used to produce compost and the fact that composting is a biological process which is more complex than, for example, many chemical processes. As a consequence, there may be a high variability in the qualities of the different compost batches produced at the same site and even more so between different compost plants. Finally, much is still unknown about what actually happens to compost and its constituents once spread on soil.

The limitations of current knowledge are also reflected in the opinion of the Scientific Committee on Toxicity, Ecotoxicity and the Environment (CSTEE; adopted on 8 January 2004) in the report ‘Heavy Metals and Organic Compounds from Wastes Used as Organic Fertilisers’ (Amlinger et al., 2004). This study was commissioned by the Directorate-General for the Environment in the framework of its background work related to possible legislative proposals concerning the biological treatment of biodegradable waste. The CSTEE concluded that the study did not provide sufficient scientific bases for the Commission to be able to propose the appropriate threshold levels for pollutants in compost. To date, there appears to be no other studies or research results that could easily provide a strictly scientific basis at a European level. The major issue remains the determination of safe levels of heavy metals in soils with regard to human toxicity and ecotoxicity.

([29]) Polychlorinated biphenyls.
([30]) Polychlorinated dibenzodioxins and dibenzofurans.

2.8.1.6 Hygiene issues and the risk of injuries

From a hygienic point of view, the application of compost is associated with risks unless the compost production is controlled appropriately. The reason is that the biological wastes used to produce compost may contain different types of pathogens, which may be bacteria, viruses, fungi, parasites and prions (at least theoretically). Compost may also contain weeds and viable plant propagules, which may encourage weed growth when spread on the land. The presence of pathogens in the input material depends on the origin, storage and pretreatment. If the composting process does not provide the required conditions to reduce or even eliminate the pathogens during the composting process, these pathogens may still be present in the compost, and, in the worst case, some of them may even have multiplied during composting. After application to land, the pathogens may then infect animals, plants or humans and pose serious health and plant disease control problems. Particular care needs to be taken in the case of grazing animals and in the production of salads, vegetables and fruits that grow close to the ground and may be consumed raw.

The main measures for controlling the contamination of compost with pathogens are to sort out especially risky material, such as nappies, from the compost feedstock and to ensure that all of the material in the compost process is subject to temperature-time profiles that kill off the pathogens (sanitation) or reduce the population to an extent where it is considered to be below a specific hazard threshold.

Macroscopic impurities of compost (especially plastic, glass and metal objects) not only reduce the aesthetic value of land, they also bring the risk of accidents, such as worker injuries when handling compost containing glass fragments.

When compost is used as a component in growing media, direct health and safety aspects are of special importance because of the often quite intense contact workers have with the material. Macroscopic glass fragments, for example, must not be present.

2.8.1.7 Positive environmental effects

The use of compost as an organic fertiliser can, to some extent, replace the use of mineral fertilisers. This is clearer for potassium and phosphate than for nitrogen because the nitrogen contained in the organic matter of compost only slowly becomes available to plants. If compost is used to reduce the need for mineral fertiliser, some of the environmental stresses of fertiliser production can be avoided. These include greenhouse gas emissions (N_2O and energy-related emissions), and impacts of phosphate extraction. The use of compost over longer periods of time and a lower use of mineral fertilisers also reduces nitrate leaching.

The humus produced from compost increases soil organic matter and stores some of the biomass carbon contained in compost in soil for longer periods of time. This carbon can be considered sequestered from the atmosphere, which acts against global warming.

Other potential positive environmental effects that have been attributed to compost include:

- reduced soil erosion;
- compost of a good quality may help to control plant diseases and thus reduce the need for applying pesticides;

- water retention is improved, reducing the need for irrigation and reducing the risk of flooding;
- the improved soil structure reduces the need to work the soil with agricultural machinery and the related use of fuel.

When compost can be used instead of peat in growing media, there is also a lower global warming potential, mainly because peat degrades relatively quickly under the release of 'long cycle' CO_2 when exposed to oxygen. Replacing peat also contributes to the protection of the biodiversity and landscape value of peatlands and bogs.

2.8.1.8 Conclusions with regard to managing potential environmental and health effects for compost

There are three main groups of environmental and health issues related to composting that need to be managed.

1. Climate change

Choices about how to manage and treat the putrescible fraction of MSW have a substantial influence on the net greenhouse emissions caused in the EU. The Landfill Directive addresses this by requiring that biological wastes be diverted from landfills. In principle, composting is a valid recovery route that allows such diversion (the environmentally best treatment option needs to be assessed in each specific case; for this purpose, life cycle guidelines for the management of the organic fraction of municipal waste have been prepared by the JRC for DG Environment and are currently in a final draft value stage. The most critical factors for a high performance of composting with respect to greenhouse gas emissions is the minimisation of methane and N_2O emissions during the composting process, pretreatment and storage.

2. Local health and environmental impacts and risks at, and close to, the composting facility

Odour, gas emissions, leachate, and pathogens in bioaerosols are released from composting processes and may affect the local environment and the health and well-being of workers and residents. Plant permits for composting facilities address these issues more and more appropriately and some Member States have issued guidelines on state-of-the-art composting techniques that help address these aspects. Composting plants with a capacity of more than 75 tonnes per day are covered in the Industrial Emissions directive([31]), as well as anaerobic digestion plants with a capacity of at least 100 tonnes per day.

3. Soil, environment and health protection when using compost, especially when applying compost to land

This aspect is highly complex because it requires managing the trade off of the benefits of compost application on land with the environmental and health risks associated with releasing a material derived from waste that potentially contains many chemical compounds (including heavy metals and potentially organic pollutants) and biological agents on soils. Whether the

([31]) Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (OJ L 334 17.12.2010, p. 17) benefits outweigh the risks depends on the quality of the compost and the local conditions under which it is applied. The complexity is aggravated by the fact that there are important knowledge gaps regarding soil properties and functions and the interactions with compost and its components. Nevertheless, it is widely accepted that the use of quality assured compost with relatively low pollutant contents following good agricultural practices allows achieving long term benefits to the soil-plant system that outweigh the risks and potential negative impacts.

Member States where the use of compost plays a substantial role have usually put regulations in place to ensure a positive trade-off, considering the specific situations of the countries. Depending on the countries or regions, the use of compost is regulated by soil protection, fertiliser or waste legislation or combinations thereof. If the introduction of European end-of-waste criteria changes the waste status of compost in a Member State, then this may affect the system of rules applying to the use of compost on land. This will then impact on the corresponding levels of soil, health and environmental protection.

2.8.2 Environmental and health effects of digestate

2.8.2.1 Introduction

Data regarding environmental and health effects of anaerobic digestion and digestate production are rather limited, compared with the data available on composting. The basic difference between composting and anaerobic digestion is the presence, respectively absence of oxygen in the process, which generates different emissions. Whereas these emissions are mainly composed of CO_2 in composting, CH_4 is the main gas formed during anaerobic digestion. Hence, it is important to note that any leaks from the digestion process should be avoided because the greenhouse gas potential of methane is more than 20 times larger than that of carbon dioxide. Gaseous emissions are thus the major point of possible concern for anaerobic digestion installations.

2.8.2.2 Gaseous emissions

Enviros Consulting performed a study in 2004 for the UK Office of the Deputy Prime Minister ([32]) to investigate the necessary planning considerations and impact of newly built MSW management installations. For anaerobic digestion, the following issues were listed (among others): published data on air emissions from anaerobic digestion facilities are extremely limited, and the derivation of emission estimates that has been achieved is based upon a single study. From that data, the preliminary conclusion is that the emissions from anaerobic digestion are low compared with those for other waste disposal options ([33]). As the anaerobic digestion process itself is enclosed, emissions to air should be well controlled. However, as biogas is under positive pressure in the tank, some fugitive emissions may arise.

There is also the potential for bioaerosols to be released from the anaerobic digestion process, mainly from feedstock reception and the eventual aeration of the digestate. The separated dewatered fraction of the digestate should be stored properly in order to avoid methane emission (Lukehurst et al., 2010).

([32]) Enviros Consulting, 2004, Planning for Waste Management Facilities: A Research Study, 238 p.
([33]) Comparison of Emissions from Waste Management Options, Research Undertaken for the National Society for Clean Air and Environmental Protection, June 2002

In 2010, the Netherlands introduced emission factors for calculations within the framework of the National Inventory Report. The factors relate to fruit, vegetable and garden waste separately collected from households. The emission factors have been drafted following a study that showed large spreads on emission factors from several National Inventory Reports of various countries. The emission factors for digestion are 1100 g CH_4/tonne input material, 2.3 g NH_3 /tonne input material, 46 g N_2O /tonne input material, 180 g NO_x /tonne input material and 10.7 g SO_2 /tonne input material. This compares to the emission factors for composting, which are 750 g CH_4 /tonne input material, 200 g NH_3/tonne input material and 96 g N_2O /tonne input material.

At the same time, the European Biogas Association states that anaerobic digestion offers the advantage of reducing emissions by avoiding emissions from open storage of e.g. manure or landfilling of unstable organic matter.

Based on the feedback received from Belgium, in a digestion plant with a QAS system, the removal of digestate is rather performed in a semi-continuous way, so that only some biogas is released into the environment. Even if the maximum fermentation is not reached at that moment, a removal of digestate does not lead immediately to methane production. When the digestate is cooled down, the digestion process will be cut off (similar to the storage of manure in a manure pit). Also when separated fibre fraction or dewatered digestate is aerated, there will be no further methane release, but CO_2 will be formed instead of CH_4, which in terms of emissions has less impact on the environment.

Finally, according to a study from the German Environment Ministry[34], anaerobic digestion offers clear greenhouse gas savings when performed properly, despite small emissions that may occur at the plant.

2.8.2.3 Other emissions

- *Dust/Odour*

  One of the main perceived planning issues associated with anaerobic digestion has been the potential for generation of odour. Odours from any mixed waste or putrescible waste facility have the potential to represent a nuisance issue, particularly when waste is allowed to decompose in uncontrolled anaerobic conditions, due to poor storage for example. However, as the anaerobic digestion process is largely enclosed and controlled, the potential for odour is greatly reduced. Dust can sometimes be generated when waste is loaded and unloaded, and when waste is transported onto manoeuvring areas on vehicle wheels. Digestate may be injected in land in order to reduce ammonia and odour emissions (Lukehurst et al., 2010). Furthermore, according to Lukehurst et al. (2010), the anaerobic digestion process induces a reduction of volatile fatty acids, hence reducing odour nuisance typical for many slurries and especially manure.

- *Noise/Vibration*

  The noise and vibration associated with anaerobic digestion will be similar to that associated with other waste treatment plants. The process operations are not inherently noisy, although vehicle manoeuvring, loading and unloading, as well as engines and pumps, are potential sources of noise.

[34] http://www.ifeu.de/landwirtschaft/pdf/BMU-Biogasprojekt%202008-Broschuere.pdf

- Water Resources

Waste water can be produced when the solid digestate is de-watered (depending upon the specific type of anaerobic digestion treatment). This can contain relatively high concentrations of metals, dissolved nitrogen and organic material, and may cause pollution if left untreated. This waste water may be disposed of to sewer and treated at a sewage works, but if the level of contaminants breaches the level imposed by the water companies, on-site treatment may be necessary.

2.8.2.4 Hygiene issues related to anaerobic digestion

In general, anaerobic digestion provides a hygienisation of the input material.

Lukehurst et al. (2010) mentions following advantages of anaerobic digestion:

- Very effective lowering of the pathogen load, such as gastrointestinal worm eggs, bacteria and viruses[35]
- Plant pathogen reduction and spore destruction
- Weed seed reduction

However, according to the German Environment Ministry, plant pathogens like the Tobacco Mosaic Virus may not be reliably reduced by an anaerobic digestion process. From a precautionary point of view the use of digestate in certain crops such as tobacco or tomato and similar susceptible plants that are used to be grown in green houses is not appropriate.

2.8.2.5 Conclusions with regard to environmental impacts of anaerobic digestion

A consortium by Enviros Consulting, the University of Birmingham and DEFRA published a "Review of Environmental and Health Effects of Waste Management: Municipal Solid Waste and Similar Wastes"([36]). Figure 3 presents the environmental effects for several MSW management options. It follows from the study that anaerobic digestion, if well performed, does not constitute any major environmental burden and even provides benefits to flora/fauna and soils.

[35] According to studies ordered by the Flemish OVAM, lowering of the pathogen load is obtained by thermophilic digestion, but not by mesophilic digestion

([36]) http://www.defra.gov.uk/environment/waste/statistics/documents/health-report.pdf

Activity	Noise	Odour	Dust	Flora/ fauna	Soils	Water quality/ flow	Air quality	Climate	Building damage
Materials recycling facility	✗	✗	✗	✗	✗	✗✗	✗✗	–	–
Composting	✗✗	✗✗✗	✗✗	✓	✗ ✓	✗✗	✗✗✗	✗	–
Mechanical biological treatment	✗✗	✗✗✗	✗✗	–	–	✗✗	✗✗	✗	✗
Anaerobic digestion	✗✗	✗✗	✗	✗ ✓	✗ ✓	✗✗	✗✗	✗	✗
Gasification/ pyrolysis	✗✗	✗✗	✗✗	–	–	–	✗✗	✗	✗
Incineration with pre-sorting	✗✗	✗✗	✗✗✗	✗✗	✗✗	✗✗	✗✗✗	✗	✗
Incineration	✗✗	✗✗	✗✗✗	✗✗✗	✗✗✗	✗✗✗	✗✗✗	✗	✗
Landfill	✗✗✗	✗✗✗	✗✗	✗✗✗ ✓	✗✗✗	✗✗✗	✗✗✗	✗✗✗✗	✗
Waste transfer stations	✗✗	✗✗✗	✗	–	–	✗✗	✗	✓	–

Category	Meaning
✓	Direct or indirect benefit
–	No effect
✗	Unlikely to be significant
✗✗	Potentially significant impact in some cases, but can be controlled
✗✗✗	Impact can normally be controlled, but an issue at sites if design, engineering or operation falls below best practice
✗✗✗✗	An issue at all sites

Figure 3: Summary of key environmental issues for several MSW management options(37)

Regarding possible health impacts, the data did not indicate any major health risk from MSW management in general or from anaerobic digestion in particular.

As indicated in Figure 3, anaerobic digestion provides several major beneficial environmental effects. Lukehurst et al. (2010) list the positive effects of anaerobic digestion:

- Biogas produced through anaerobic digestion is a source of renewable energy
- Digestate is a highly valuable biofertiliser that can partially replace mineral fertilisers
- Digestion reduces greenhouse gas emissions from open manure stores
- Digestion provides a highly efficient method for resource recycling

(37) http://www.defra.gov.uk/environment/waste/statistics/documents/health-report.pdf

3 JRC Sampling and analysis campaign

3.1 Background information

A very important discussion issue raised during the first workshop on 2 March 2011 in Seville was the necessity of reliable and state-of-the-art scientific data on the levels of organic and inorganic pollutants in different types of compost and digestate to support the decision-making process for end-of-waste criteria. Especially on the issues of allowing sewage sludge compost/digestate and compost/digestate based on mechanical biological treatment, extensive discussions were held, indicating the need to obtain recent scientific data allowing comparative analysis. Furthermore, the availability of scientific data on inorganic and organic pollutants turned out to be less ubiquitous for digestate than for some compost types.

It was understood that these necessary scientific data could only be generated through a pan-European collaborative screening exercise. Such a campaign, consisting of measuring a large series of biodegradable waste samples in the best possible standardized way, was therefore organized in May-September 2011.

The two objectives of the collaborative screening exercise were:

1. Generate, within a limited timeframe, a large amount of analytical data, with high scientific and statistical value, for a number of compost and digestate types, to allow a general overview and estimation of possible variability of pollutant levels within and between different compost/digestate materials and technologies.
2. Guarantee maximal objectivity, minimal variation and the smallest possible bias upon sampling by independent, unannounced control sampling performed by a single team composed of EC JRC staff only, at selected plants participating in the collaborative screening exercise.

The results from this collaborative screening exercise will feed the discussions regarding end-of-waste criteria such as e.g. product quality, input materials or quality assurance. The Institute for Environment and Sustainability (JRC-IES) in Ispra (Italy) had already been making provisions for the FATE-COMES study on composts and biowaste materials, following previous successful pan-European measurement campaigns such as FATE-EUMORE (surface water), FATE-GROWS (groundwater) and FATE-SEES (sewage sludge and effluents). Their study formed the basis for the current collaborative screening exercise.

The screening exercise, within FATE-COMES, featured following key elements:

- 162 samples were collected, georeferenced and distributed over the following categories:
    - Compost produced from separately collected organic waste from households and similar commercial institutions, including garden and park waste
    - Compost produced from garden and park waste only (green compost)
    - Sewage sludge compost produced from good quality sewage sludge and other separately collected organic waste (e.g. garden and park waste, straw, etc.)
    - Municipal Solid Waste compost generated by Mechanical Biological Treatment aimed at producing compost (derived from non-hazardous household waste and similar commercial waste where no separate collection of household waste is in place)

- Digestates from source separated biowastes from households and similar commercial institutions (liquid and solid fraction)
- Digestates from manure and source separated biowastes from households and similar commercial institutions (liquid and solid fraction)
- Digestates from manure and energy crops (liquid and solid fraction)
- Digestate derived from Mechanical Biological Treatment of Municipal Solid Waste, aimed at producing digestate for use in agriculture (derived from non-hazardous household waste and similar commercial waste)
- Other, minor categories. These include bark compost or municipal solid waste compost like output generated by Mechanical Biological Treatment aimed at stabilizing a rest fraction sent to landfill.

- For the first objective, allowing a broad screening of different materials and technologies, samples were taken by the compost/digestate producers, in sample containers provided by the JRC-IES, and shipped back to JRC-IES for analysis.
- For the second objective, the JRC selected a number of compost/digestate producing plants from the list of participating producers, in order to visit these unannounced (last week of June 2011). The JRC team took their own samples for measurement by JRC-IES. Nineteen different samples were taken during the sampling campaign, in Italy, France, Belgium, The Netherlands and Germany.

3.1.1 List of envisaged measurement parameters

The FATE-COMES study envisaged the measurement of following parameters (Table 8).

Table 8: Envisaged parameters for measurement on compost and digestate samples

Compounds class	*Method principle*
Perflurorinated surfactants (including PFOS, PFOA)	LC MS
Heavy metals (including Ag, Al, As, Ba, Cd, Co, Cr, Cu, Fe, Mg, Mn, Mo, Ni, Pb, Sb, Se, Ti, Tl, V, Zn)	ICP-OES
Mercury	CV AAS
PCBs	GC-MS
PCDD/Fs	GC-MS
PAHs	GC-MS
Siloxanes	LC-MS
Polycyclic Musks	LC-MS
Nonylphenol and -ethoxylates	LC-MS
PBDE	LC-MS
Veterinary drugs, pharmaceuticals	Various
Estrogene activitiy (bio-asssay)	CALUX

The various compounds are measured by JRC laboratories and selected partner laboratories. The laboratories follow their validated in-house methods. JRC IES labs are ISO 9001 certified. Partner laboratories are accredited laboratories under ISO 17025. Where possible, so-called horizontal standards of CEN TC 400 are used or at least the provisional prEN standards.

3.1.2 Sampling methods

In order to reduce the organizational and financial efforts for participating plants, there was no obligation to perform independent sampling by external accredited sample takers and plants were allowed to perform the sampling themselves. Where possible, JRC recommended using EN 12579 for solid samples and EN ISO 5667-13- 1997 "Water quality -Sampling - Part 13: Guidance on sampling of sludges from sewage and water-treatment works" for liquid samples. Alternatively, plants could use their usual sampling method.

3.1.3 Sampling protocol

The European Compost Network had prepared a sampling protocol, which was a modified version of the Sampling Record described in their Quality Assurance Scheme and which was distributed by the JRC to the participating plants.

3.2 Status

At the date of publication of this working document, nearly all samples from the plants having expressed their interest to participate had been collected.
The degree of participation by the various Member States generally was in line with the production level of compost and digestate. In order to avoid bias by overrepresentation of certain technologies or regions, certain plants were not shortlisted for the final screening exercise.
The initial focus has been on analyzing the samples collected by the JRC and their counterparts sampled by the plants themselves and shipped to the JRC.

3.3 Analytical results

3.3.1 Introduction

First of all, it should be stressed that available data at the moment of publication of this working document are very limited. As such, it is difficult to draw any definite conclusions. Nevertheless, first available data are reported here, as the whole of the dataset, rather than individual measurements, may shed light on the differences in quality between the various materials.

The data are expressed on dry matter basis. The encountered concentrations of the different pollutants do not per se imply the existence or not of an environmental risk upon usage. To assess this risk, plant transfer studies should be performed or literature data scrutinized. Hence, the concentration differences between the different samples can point only to the performance of the different technological approaches in removing or avoiding certain pollutants in the end material.

In view of respecting the anonymity of the participating plants, this report has omitted the exact geographical location and description of the participating plants. In general, it can be stated that the plants used do not represent any particular exceptions such as the treatment of special input material. Moreover, they were all using modern technology.

The data below are represented in pairs, with samples sent by the plant marked as "Plant" at the end of the code, and samples collected by the JRC marked as "JRC".

Data for following plants is presented in this document:

1. Green waste compost from green waste originating from gardens and parks through separate collection (Germany)
2. Sewage sludge compost, made up of sewage sludge and green waste from separate collection as input materials (Germany)
3. Compost derived from separately collected biowaste from households (biobin) as well as garden and park waste from separate collection (Germany)
4. Liquid digestate from thermophilic digestion of biowaste derived from separate collection by households (biobin) (Germany)
5. MBT compost from mechanical biological treatment of mixed municipal waste from households (which should not contain hazardous substances) (France)

3.3.2 Heavy metals

The results of the heavy metal analysis are depicted in Figure 4.

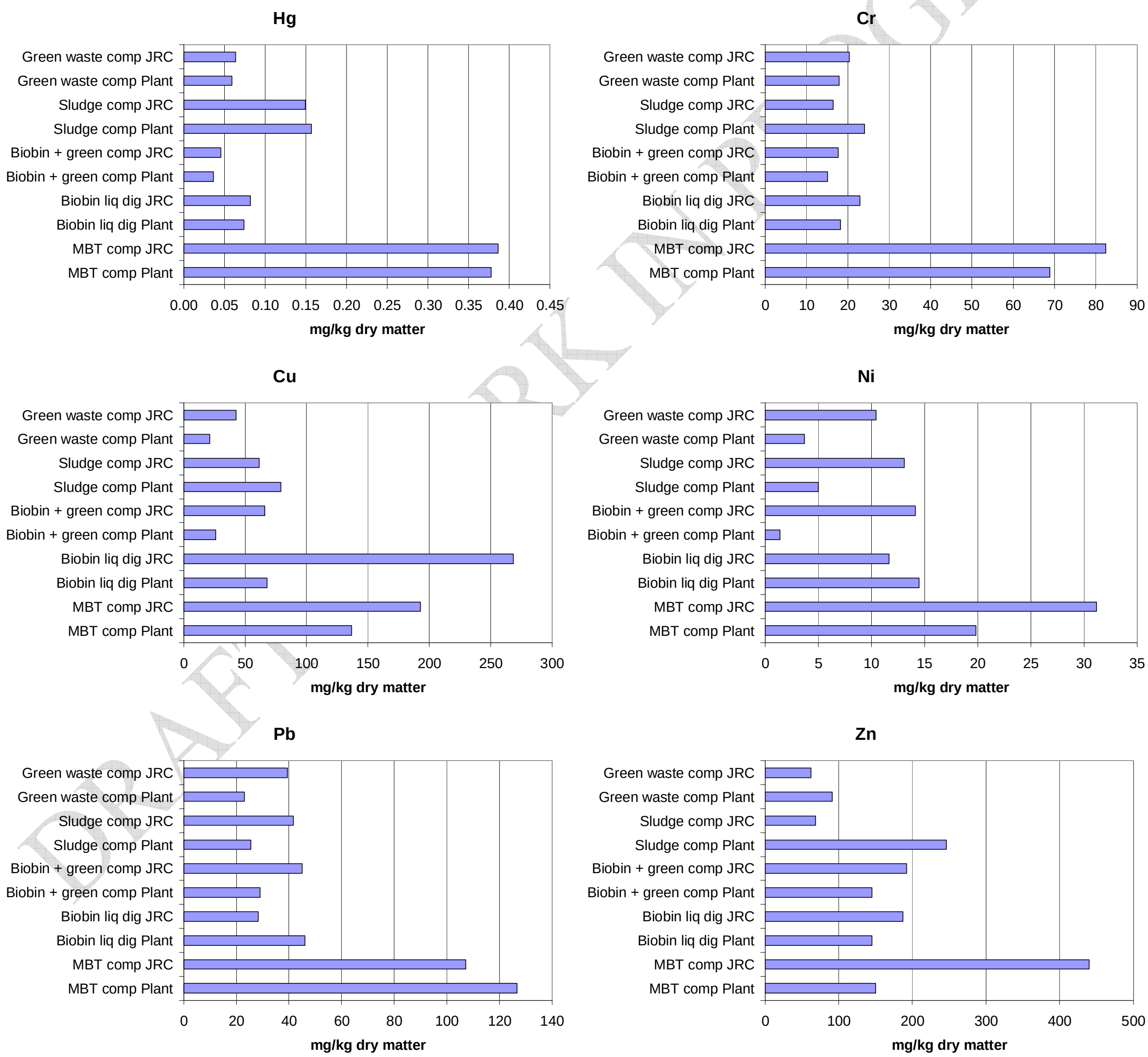

Figure 4: Heavy metals in compost and digestate samples collected by JRC and sent by plants. Legend: biobin=biowaste from separate collection (households and similar), comp=compost, dig=digestate, green= green waste, liq=liquid, MBT=mechanical biological treatment (composting of mixed municipal waste after mechanical separation), JRC=sampled by JRC, plant=sampled by producing plant

In general, it follows from the analytical data that good agreement is achieved between samples collected by the compost or digestate producing plants and the JRC, indicating a relatively constant quality in time and little dependence of the sample taking.

Generally, the concentrations of heavy metals are in the same range for most samples, except for the MBT samples that display large concentration peaks. More specifically, it is noted that the highest concentrations of heavy metals are encountered in the MBT compost samples, for nearly all metals. The high concentrations of heavy metals are encountered in both samples, except for Zn. One of the liquid digestate samples of separately collected biowaste displays a high Cu concentration, although this is not confirmed by the other sample. Hg levels also appear higher in both samples of sewage sludge compost, compared to the other materials.

With the currently proposed heavy metal concentrations for compost/digestate (see following chapter under Product Quality Requirements), one liquid digestate sample exceeds the proposed maximum concentration for Cu (100 mg/kg dry matter), whereas several MBT compost samples exceed proposed limits for Cu (100 mg/kg dry matter), Pb (120 mg/kg dry matter) and Zn (400 mg/kg dry matter).

3.3.3 Organic pollutants

3.3.3.1 Polychlorinated biphenyls (PCB) and dioxins

Polychlorinated biphenyls and dioxins have been banned or limited by the Stockholm Convention on Persistent Organic Pollutants. The toxicity of PCB is related to that of dioxins and comprises carcinogenic effects, endocrine disruptive effects and neurotoxicity.

Analytical results on PCBs and dioxins are depicted in Figure 5.

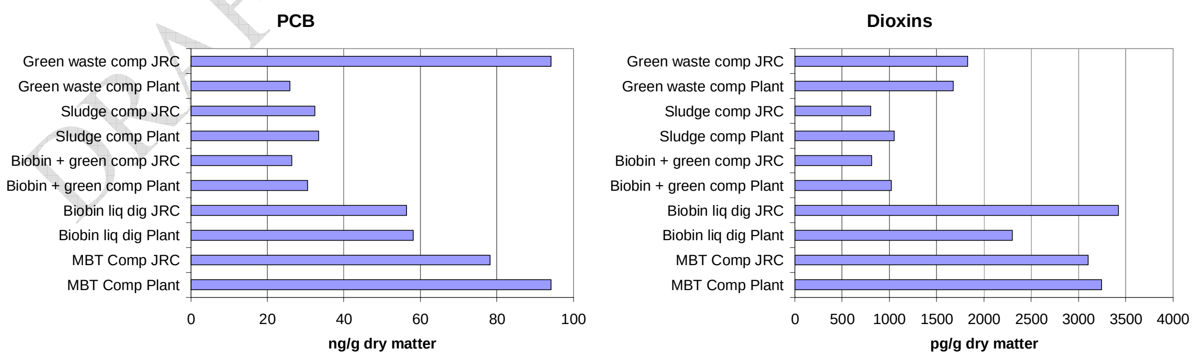

Figure 5: PCBs and dioxins in compost and digestate samples collected by JRC and sent by plants. Legend: biobin=biowaste from separate collection (households and similar), comp=compost, dig=digestate, green= green waste, liq=liquid,

MBT=mechanical biological treatment (composting of mixed municipal waste after mechanical separation), JRC=sampled by JRC, plant=sampled by producing plant

Generally, the concentrations of PCBs and dioxins are in the same range for most samples.

It is noted that the PCB concentration is highest in both MBT samples and one green waste compost sample (not confirmed by other sample). Dioxin concentration is highest in both MBT samples and digestate samples.

3.3.3.2 Polybrominated diphenyl ethers (PBDE)

Polybrominated diphenyl ethers, used as flame retardants, are partially subject to the Stockholm Convention on Persistent Organic Pollutants. PBDEs and their partial breakdown products from natural decomposition display similar toxicological effects as PCBs.

Analytical results on PBDEs are depicted in Figure 6.

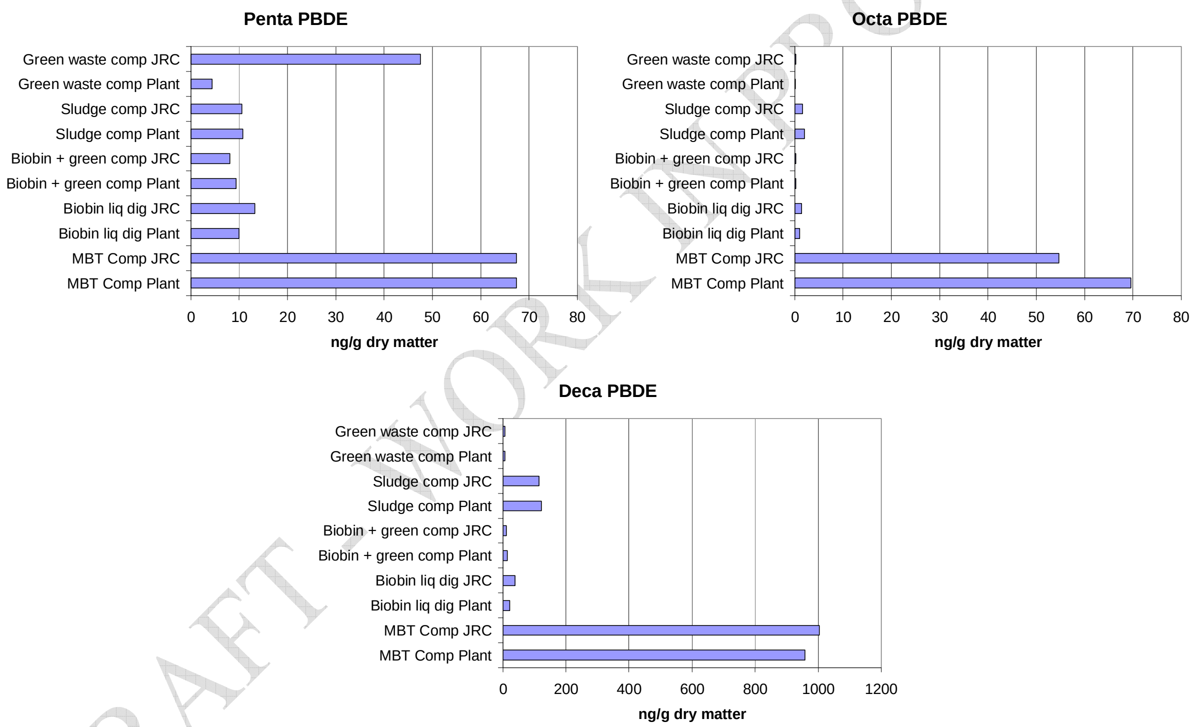

Figure 6: Polybrominated diphenyl ethers in compost and digestate samples collected by JRC and sent by plants. Legend: biobin=biowaste from separate collection (households and similar), comp=compost, dig=digestate, green= green waste, liq=liquid, MBT=mechanical biological treatment (composting of mixed municipal waste after mechanical separation), JRC=sampled by JRC, plant=sampled by producing plant

Here it is clearly seen that concentrations are no longer in the same range for the different materials but differ over two orders of magnitude in some cases. Whereas most materials still display comparable concentrations of penta-formulated PBDEs (one outlier for one green waste compost sample but not confirmed by other sample), octa-formulated and deca-formulated PBDE concentrations clearly depend on the type of material. Octa-formulated PBDE concentrations are visibly much higher for the MBT samples than for the other samples and deca-formulated PBDE samples are undoubtedly much higher for the MBT samples and sewage sludge compost samples than for any of the other samples.

3.3.3.3 Polycyclic musks

Polycyclic musks are used as fragrances in cosmetics, detergents, and other products. Although their human and eco-toxic effects are generally estimated to be lower than for other persistent organic pollutants, they are known for their low biodegradability and there is concern about bioaccumulation.

Analytical results on two polycyclic musks, tonalide and galaxolide, are depicted in Figure 7.

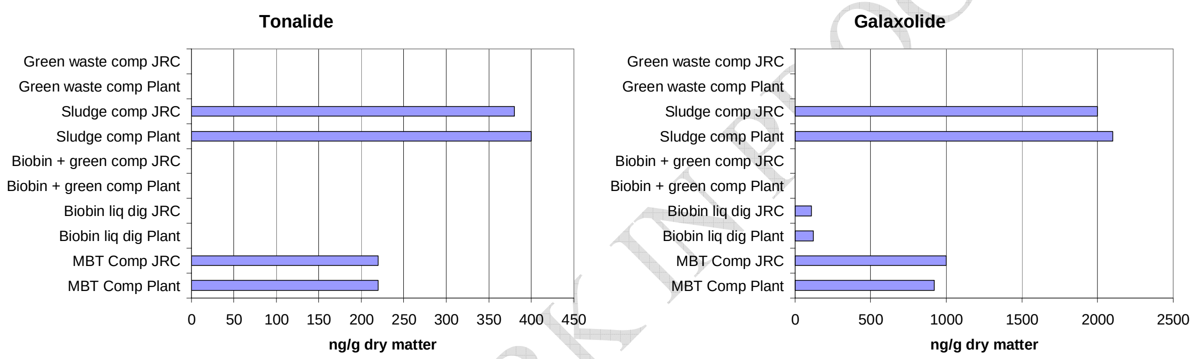

Figure 7: Polycylic musks (tonalide and galaxolide) in compost and digestate samples collected by JRC and sent by plants. Legend: biobin=biowaste from separate collection (households and similar), comp=compost, dig=digestate, green= green waste, liq=liquid, MBT=mechanical biological treatment (composting of mixed municipal waste after mechanical separation), JRC=sampled by JRC, plant=sampled by producing plant

From the graphs, it follows that polycyclic musk concentrations are very high in both the sewage sludge compost samples and MBT samples. Concentrations were below the detection limit or absent in the other samples.

The discrepancy in concentration of the polycyclic musks between the different materials is linked to the fate of many personal care and laundry products, which are either discharged into the household waste or removed with the wastewater of the households. The musks are very unlikely to come into contact with biowaste from households or green waste, hence their absence in these materials and the compost or digestate derived from them.

These figures suggest that other compounds present in personal care and laundry products could also end up in sewage sludge compost or MBT compost, such as pharmaceuticals. This will have to be confirmed by further analytical data.

3.3.3.4 Fluorosurfactants (PFC)

Fluorosurfactants are used in many industrial processes and as stain repellents. They include perfluorooctanesulfonic acid (PFOS), perfluorooctanoic acid (PFOA), and perfluorononanoic acid (PFNA). Their toxicity mechanisms include carcinogenic and endocrine dirsruptive effects.

Analytical results on PFOS, PFOA and PFNA are depicted in Figure 8.

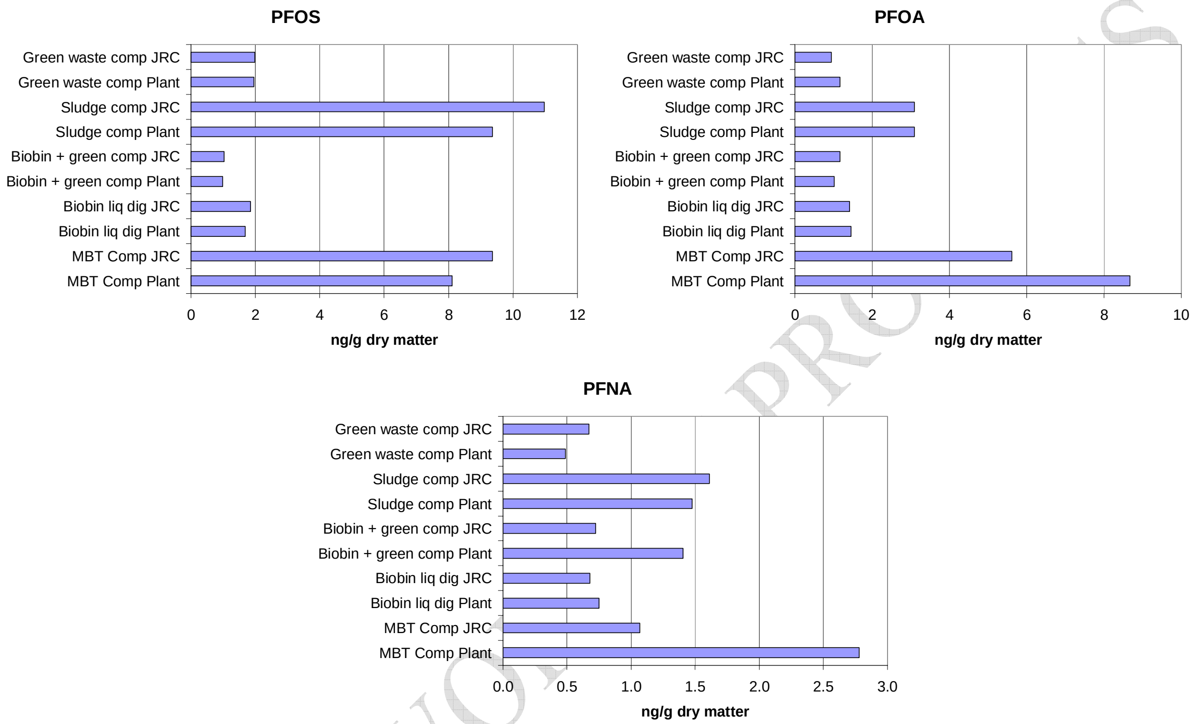

Figure 8: Fluorosurfactants (PFOS, PFOA, PFNA) in compost and digestate samples collected by JRC and sent by plants . Legend: biobin=biowaste from separate collection (households and similar), comp=compost, dig=digestate, green= green waste, liq=liquid, MBT=mechanical biological treatment (composting of mixed municipal waste after mechanical separation), JRC=sampled by JRC, plant=sampled by producing plant

The graphs clearly demonstrate that fluorosurfactants appear in all analyzed materials. Again, it is noted that the highest concentrations are encountered in all sewage sludge compost samples and all but one MBT compost sample.

3.3.4 Conclusion and recommendations

In general, it can be concluded from these preliminary data that:

- **MBT compost** samples contain very high concentrations of heavy metals and organic pollutants, compared to the other sampled materials. This was confirmed by the measurements of both the JRC sample and the sample provided by the plant.

- The concentration of heavy metals and organic pollutants in **sewage sludge compost** was often comparable with that of the other materials, except for Hg, certain polybrominated diphenyl ethers, polycyclic musks and certain fluorosurfactants, where the measured concentration was much higher than in the materials from separate collection of biowaste and green waste. Data were confirmed by the measurements of both the JRC samples and the samples provided by the plant. This suggests that sewage sludge forms a sink for mercury and many persistent organic pollutants.

- Other materials occasionally exhibited high concentrations of certain pollutants in either the sample collected by the JRC or by the producing plant, but this was not confirmed by the measurement of the other sample.

Given the limited data that are available, no firm conclusions can be drawn up at this moment. However, based on the available preliminary data, and in respect of the precautionary principle, it is recommended that MBT compost and digestate as well as sewage sludge compost and digestate are to be excluded from eligibility for end of waste status.

4 End-of-waste criteria

4.1 Background information

4.1.1 Introduction

End-of-waste criteria for a material should be such that the recycled material has waste status if – and only if – regulatory controls under waste legislation are needed to protect the environment and human health.

Criteria have to be developed in compliance with the legal conditions set out in Article 6 of the WFD, be operational, not lead to new disproportionate burdens and undesirable side-effects, and consider that the collection and treatment of biodegradable waste into e.g. compost is a well-functioning practice today. Criteria have to be ambitious in providing benefits to as many flows as possible, but must also ensure protection of the environment and human health through strictness. The criteria must address with priority the main and largest represented flows in the EU fulfilling the conditions of the WFD. Criteria cannot fail to target these priority flows by trying to encompass all existing biodegradable waste flows, and all national and regional singularities.

Through end-of-waste, the intention is to promote more recycling and use of waste materials as resources, reduce consumption of natural resources and reduce the amount of waste sent for disposal. A material which satisfies a set of end-of-waste criteria can then be freely traded as a non-waste material and thereby its beneficial use promoted. Potential users of the material should be able to have increased confidence on the quality standards of the material and this may also help to alleviate any user prejudice against the material simply because it is classified as waste.

This chapter suggests how the end-of-waste criteria for compost and digestate would have to be defined so that they fulfil the conditions and purposes specified in Article 6 of the WFD. It first identifies and discusses the different reasons why the end-of-waste criteria for compost and digestate would be beneficial, then it goes through the four conditions of Article 6 and analyses what they mean for the specific case of compost and to a lesser extent for digestate. Finally, a set of end-of-waste criteria on compost and digestate and accompanying measures are proposed accordingly.

4.1.2 Rationale for end-of-waste criteria

The purpose of having end-of-waste criteria is to facilitate recycling and to obtain environmental and economic benefits. This section discusses how, i.e. through which mechanisms, end-of-waste criteria may achieve this in the case of compost and digestate.

4.1.2.1 Improve harmonisation and legal certainty in the internal market

There are environmental and economic benefits to be gained as the end-of-waste criteria improve the harmonisation and legal certainty in the internal market.

There is currently no harmonised way in the EU for determining whether a compost or digestate material is a waste or a ‘normal’ product. Member States deal with the question rather differently. There is a group of Member States where there are types of composts or digestates that are explicitly recognised as non-waste even if they are produced from input materials that are waste. However, across these Member States, the standards that composts and digestates must meet in order to qualify as normal products differ considerably. Then there are other Member States where composts or digestates made from waste are always considered waste, regardless of the quality of the material. In the remaining Member States there are no explicit general rules and the classification of compost/digestate as waste or not is left to case-by-case decisions or to interpretive protocols that are applicable to certain parts of the Member State.

The lack of harmonisation creates legal uncertainty for waste management decisions and for the different actors dealing with the material, including the producers and users of compost/digestate or haulage contractors. The uncertainty arises especially when trade between Member States is involved. However, there are also differences in interpreting the waste status of compost and digestate between different regions within certain Member States.

One identified consequence is that both compost/digestate producers and users tend to restrict themselves to the national (or regional) market because they want to avoid the administrative and judicial costs or risks of an unclear waste status of the material. This means that composts/digestates do not always reach the place where they could, in principle, be used best, i.e. economically and delivering the highest benefits with the proportionally lowest environmental and health risks. It may also mean that less compost/digestate is produced. In fact, the volumes of compost and digestate traded between Member States are smaller today than they could theoretically be and it is likely that with clear rules about when compost and digestate cease to be waste, the supply and demand of these materials would be balanced better.

The legal uncertainty regarding the waste status of compost/digestate also affects the investment decisions on new treatment capacities for the management of biological wastes. Such uncertainty evidently comes at a cost when it hinders the development of the composting and digestion sector in situations where, in reality, the conditions would exist for compost or digestate to cease to be waste. This is relevant not only for the situation in certain Member States, but especially also at the European level. For example, the possibility of exporting compost/digestate is an important factor for the feasibility of a composting/digestion plant in border regions. When uncertainties regarding the status of the waste reduce the export possibilities, then this may easily lead to opting for another waste treatment option even if a need and environmentally suitable absorption capacity for the compost or digestate exists across the border ([38]). Harmonised end-of-waste criteria would promote investing in compost and digestate production in such situations.

The lack of harmonisation also means that there is no system that ensures that the control of compost and digestate flows across national borders is proportionate to the related

([38]) Due to the relatively high costs of transporting the compost/digestate, the feasibility of a composting/digestion plant critically depends on the existence of sufficient market capacity for its use within a radius of not more than 50–100 km around the plant. If national borders within the EU work as barriers to compost/digestate use, then composting/digestion facilities close to borders have an obvious ‘geometric’ handicap that works to the detriment of allowing an environmentally optimised waste management and compost/digestate use.

environmental risks. Harmonised end-of-waste criteria could improve the management of environmental risks under waste shipment rules by excluding low risk compost and digestate from waste shipment controls, while making explicit that compost or digestate with higher risks for the environment have to be considered waste. This would avoid unnecessary costs and barriers in end-of-waste compost and digestate and ensure the necessary controls (prior written notification and consent of shipment) in waste compost and digestate.

Generally, end-of-waste criteria would have the benefit of making more explicit when compost and digestate have to be considered waste. This would consolidate the application of waste law derived controls to non-compliant compost and strengthen environmental and health protection.

4.1.2.2 Avoid waste status if unnecessary

There are economic benefits, when the end-of-waste criteria prevent compost or digestate being considered as waste when such a status is not necessary.

A direct economic benefit is that compliance costs are avoided. According to certain Member State legislation, users of compost or digestate may need a permit for usage from the waste management authorities. Compost or digestate not requiring a permit or an exemption under waste law can be used at lower costs. The UK's Quality Protocol for compost, for example, allows the use of compliant compost in England and Wales without having to pay an exemption fee related to waste status. The avoided costs were estimated at more than GBP 2/tonne of compost (The Composting Association, 2006) ([39]).

Another economic benefit can be obtained by avoiding potential users undervaluing compost or digestate simply because it is unnecessarily labelled as waste. It has been reported that farmers are hesitant to use compost as a soil improver if it is presented to them as a waste material because the waste status makes them perceive compost as of low value, or even causing adverse impacts to agriculture. In such cases, the waste status works as a stigma. Compost that is not considered waste has a higher perceived value than otherwise identical waste compost. In fact, it is likely that the agronomic value of compost is higher than the price paid for it when it is waste ([40]). If higher prices are paid for end-of-waste compost, then a part of the benefits obtained by the user is transferred back to compost producers and possibly, through reduced gate fees, further to municipalities so that e.g. the costs of waste management are reduced, or improvements in collection can be made.

A correctly perceived value of compost and digestate and reduced costs of compost use are important factors to strengthen the demand for compost and digestate and in this way improve the feasibility of the compost route of managing biodegradable wastes.

Examples such as Austria and the United Kingdom show that Member States can effectively avoid the waste status of certain composts and digestates already within the current European framework, but these rules are only valid within each of these Member States. There would,

([39]) In Germany, composts do not cease to be waste *before they have been used*, but quality certified composts are exempted from the most onerous obligations that a full waste status would imply for the users. Also this reduces compliance costs for the use of compost.

([40]) For instance, it was a reason for including end-of-waste criteria in the Austrian Compost Ordinance to avoid that the value of compost is unduly underestimated because of unnecessary waste status.

however, be additional benefits of the European end-of-waste criteria by accelerating and consolidating the establishment of compliant compost and digestate as a freely traded product throughout the EU.

4.1.2.3 Promote product standardisation and quality assurance

Harmonising the end-of-waste criteria is also an opportunity to introduce widely recognised product standards for compost and digestate and to promote quality assurance.

A high level of environmental protection can be achieved only if there is reliable and comparable information on the environmentally relevant product properties. Claims made on product properties must correspond closely to the ‘real’ properties, and the variability should be within known limits. To manage compost and digestate so that environmental impacts and risks are kept low, it must be possible for compost/digestate users and regulatory authorities to interpret the declared product properties in the right way and to trust in conformity. Therefore, standardisation of product parameters, sampling and testing is needed as well as quality assurance.

End-of-waste criteria that demand the use of harmonised standards could be a decisive factor for promoting the widespread use of harmonised standards throughout the EU. Harmonised standards for compost/digestate property parameters, sampling and testing are, to a large extent, already available to be used today, even if they are not yet fully adopted as European standards.

Where compost and digestate production and use are already well-established today, quality assurance is a common practice. While quality assurance can also be developed by industry alone, as a purely voluntary initiative, most of the successful compost quality assurance and certification schemes have benefited, however, from some sort of quasi-statutory support by regulations in Member States. By demanding quality assurance, the end-of-waste criteria would promote quality assurance throughout the EU.

4.1.2.4 Promote higher compost and digestate quality

The end-of-waste criteria can promote higher compost and digestate quality standards by including certain product quality requirements. Such requirements comprise limit values for hazardous components (maximum concentrations allowed) and for properties adding value to the product (e.g. minimum organic matter content). It is evident that high quality in this sense is important for a good overall cost-benefit balance of compost use. If only high-quality composts benefit from the cost reducing and demand enhancing effects of end-of-waste, they will become preferable as an option compared to lower quality composts not only for compost users but also for operators of compost plants and in strategic waste management decisions.

4.1.3 Conditions for end-of-waste criteria

This section discusses, one by one, what the conditions of end-of-waste criteria as defined in Article 6 of the WFD mean in the case of compost and digestate and how end-of-waste criteria need to be formulated so that compost or digestate only qualify when all four conditions are met.

4.1.3.1 The substance has undergone a recovery operation

Compost and digestate are materials that are the result of a recovery operation according to Article 3 (15) and Annex II R3 of the Waste Framework Directive. The recovery in this case constitutes a material recovery, as the organic matter of the input biodegradable waste is recovered and transformed into a material with more desirable properties with regard to nutrient value, soil amendment potential, sanitation, etc.

4.1.3.2 The substance or object is commonly used for specific purposes

There are a number of specific purposes for which compost and digestate are commonly used. The main use for compost and digestate is as a soil improver or an organic fertiliser in agriculture. Compost is also incorporated as a component in growing media for use in horticulture, landscaping and hobby gardening. Product specifications for using compost or digestate for these purposes exist on national levels and, to some extent, also at European level (eco-label criteria on soil improvers and growing media). Some compost is also used for land restoration and as a landfill cover. The use of compost for these purposes is common in several Member States of the EU. Digestate is almost completely applied in agriculture. The main compost and digestate producing countries are also the main compost and digestate users. The nine Member States with the biggest compost production ([41]) produce about 95 % of all compost in the EU, whereas Germany is by far the largest digestate producer of the EU accounting for nearly two thirds of all digestate produced. Depending on the purpose and the specific situation, the use of compost and digestate is regulated at least in those Member States where such use is common. For use on soil, and particularly in agriculture, there are usually restrictions on the amounts of compost and digestate that may be used, often depending on the heavy metal and nutrient contents of the material.

4.1.3.3 A market or demand exists for such a substance or object

Theoretically, there is a strong need for compost in the EU, especially as a soil improver to work against the loss of organic matter from soil (erosion). The demand for digestate mainly originates from its merits as an organic fertiliser. In practice today, the market for compost and digestate is well established only in the part of the EU where compost/digestate production and use is concentrated (see Section 4.1.3.2), and is not coincident with the regions of most erosion or nutrient depletion. In other parts of the EU, the market is being developed in a proactive manner, typically with government support. Finally, there are a number of countries in which compost or digestate does not yet play any significant role.

Where compost and digestate are being produced, the market tends to be supply-driven and prices for compost and digestate are sometimes close to or at zero. Even if globally there is more than sufficient use for the compost and digestate produced, there may be local imbalances of supply and demand.

Removing the waste status from compost/digestate that can be safely used for a specific purpose is likely to strengthen the demand for such material and help avoid local oversupply. To prevent the ultimate disposal of compost and digestate, the end-of-waste criteria must be

([41]) In decreasing order of production: Germany, France, the United Kingdom, the Netherlands, Italy, Austria, Spain, Denmark, Belgium.

demanding in terms of usefulness, ensuring a high value when used for a specific purpose. The stricter the quality requirements in the end-of-waste criteria, the higher the price will be for compost and digestate that meet them.

A compost or digestate should not cease to be waste if, in most places, it does not comply with the applicable regulations and standards on the relevant specific compost/digestate uses, because hardly any demand for the compost/digestate would exist in such a case.

Experience in countries where compost/digestate is commonly used today has shown that the compost/digestate market works well when the quality of compost/digestate supplied is high and reliable and the demand is proactively developed.

4.1.3.4 The substance or object fulfils the technical requirements for the specific purposes and meets the existing legislation and standards applicable to products

When compost or digestate is placed on the market, there must be at least one purpose for which it can be used without requiring any further treatment. It will be up to the undertaking that places the compost or digestate on the market to declare fitness for such use, referring to the applicable legislation and standards. Market surveillance by Member State authorities will also play a role.

The existing legislation and standards for using compost or digestate for the different purposes vary between countries. It is reasonable that the specific conditions and rules for the application of compost and digestate to soils (such as how much compost and of what quality may be used on certain types of soil) are regulated at the level of Member States. Diversity in soil properties, climates, land use practices, etc., throughout the EU is very high and there is a need for regulations to be adapted to the specific conditions.

Furthermore, there does not seem to be a scientifically sound and generally acceptable way to derive comprehensive, Europe-wide technical requirements for the use of compost and digestate on land, which is the main outlet for these materials. This implies that the conditions and rules for compost/digestate use cannot directly be part of the European end-of-waste criteria for compost and digestate ([42]). The declaration of fitness for use will therefore have to be adjusted to the national legislation and standards that are applicable in the place where the compost or digestate will be used.

Only for some technical requirements that are of a general nature for all typical purposes of compost or digestate use may minimum requirements be included directly in the end-of-waste criteria at EU level. The purpose of such minimum requirements would be to generally exclude composts/digestates from end-of-waste for which there is not use at all, except, maybe, in small niche applications.

In any case, there is a need for harmonised technical standardisation of compost and digestate quality parameters, sampling and testing across the EU, to avoid an artificial fragmentation of

([42]) Concerning the use of compost in products such as growing media, EU-wide rules may be justified because growing media are products traded freely on the internal market. This would primarily be a question of regulating growing media, and would affect the end-of-waste criteria for compost only indirectly.

compost or digestate markets that is not justified by the real use requirements. The end-of-waste criteria should, therefore, be based on common standardised quality parameters, as well as common standardised testing and sampling. As complementary measures, it would be important that Member States use the same harmonised standards in the relevant legislation on compost and digestate use.

4.1.3.5 The use of the substance or object will not lead to overall adverse environmental or human health impacts

There are various aspects to consider for avoiding overall adverse environmental or human health impacts.

1. Compost or digestate use should not exert any stress on soil that may compromise the multifunctional soil functions. Therefore, the transfer to soil of hazardous substances through compost/digestate application needs to be limited. This is primarily a question of rules on the use of compost/ digestate, which, as argued before, are best formulated at national/regional levels. Composts/digestates should cease to be waste only if they comply with the environmental and health regulations on compost use that apply to the purpose for which they are placed on the market (see also condition c). As complementary measures to the end-of-waste criteria, it would be important that Member States, who have not already regulated the use of composts/digestates, put such rules in place.

2. Compost/digestate should not pose any health risks because of macroscopic impurities such as plastics, metals or glass. This can best be controlled by including limits on such impurities as a quality requirement in the end-of-waste criteria.

3. The end-of-waste criteria should not lead to a relaxation of the strictness of quality for compost/digestate. This could happen if the end-of-waste criteria included concentration limits for hazardous substances that are less strict than the standards that determine the quality of compost/digestate produced today. One may think that in this way more compost/digestate could benefit from the advantages of EoW, which would promote recycling. However, if the thresholds are less strict, then the overall adverse environmental impacts can only be avoided by using less compost, which would work against the aim of promoting recycling.

   As part of the product quality requirements, maximum limits for a number of substances will have to be introduced, striking a balance between ensuring environmental and health protection, and providing the advantages of EoW to as much compost and digestate flows as possible.

4. Lifting the waste status should not create any regulatory void that would impair the management of environmental and health risks. The introduction of harmonised end-of-waste criteria will require the authorities in Member States to reconsider the waste status of composts and digestates. This will, in some cases, mean that certain composts/digestates that used to be considered waste can be considered non-waste. Such a change would mean that the legal and administrative controls available under waste law do not apply any longer. If in a given Member State the legislative measures for control of compost/digestate use are independent from the status of

compost/digestate as waste, they will not be affected by a change to EoW. Conversely, if such measures are part of, or linked to waste law, they would be affected by a change to EoW, for instance:

- Permits for the application of compost/digestate on land and for other compost uses such as the preparation of growing media including compost;
- Inspection of compost/digestate users, collectors or transporters by the competent waste authorities;
- Obligation of compost/digestate users to keep records of the quantity, nature and origin of compost;
- Prior written notification and consent of shipment;
- Registration by the authorities of transporters, dealers and brokers of waste.

The logic of the end-of-waste criteria requires that only compost or digestate for which waste law- based controls are not needed should qualify, either because the inherent risks and impacts of the materials are sufficiently low, or because there are other regulatory controls to deal with them independently of the status as waste. The use of the compost/digestate under different conditions should be possible without any danger to the environment and to health.

The inherent risks of the material are determined by the content of impurities and pollutants (hazardous substances) as well as the hygienic properties of the compost or digestate. The end-of-waste criteria can limit the environmental and health risks by including certain product quality requirements regarding pollutants and impurities, restrictions on the input materials used to produce the compost/digestate, and process requirements to eliminate pathogens from the material.

As stated above, composts/digestates should cease to be waste only if they are placed on the market for a purpose for which adequate rules on the use of compost/digestate apply. As complementary measures, such rules should be established where they do not yet exist. In several Member States, there are already soil protection and/or fertiliser laws that regulate the use of compost/digestate independently of the waste status. Often reference is made to good agricultural practices, or application recommendations for compost/digestate are provided. Compost or digestate should not cease to be waste if it does not meet the product quality requirements for the main use purposes or in most places. This should be considered when determining the product quality requirements (e.g. concentration limits on hazardous substances) for the end-of-waste criteria.

Private quality assurance schemes play an important role in risk management in a number of countries, and sometimes are made quasi-compulsory (statutory) by reference in the relevant legal (waste or other law) instruments.

Finally, there is also the possibility of introducing new complementary control instruments especially designed for non-waste compost or digestate. As an example, new requirements for ensuring the traceability of compost and digestate might be established independently of the waste laws in certain markets where this is desirable. The key question for any new controls introduced together with end-of-waste criteria is if these specific controls are better suited to deal with the compost/digestate-specific risks than the general controls linked to the status as a waste, considering that disproportionate new burdens need to be avoided. The inclusion of additional administrative measures for EoW compost/digestate which waste compost/digestate does not require may deter the uptake of EoW by producers.

4.2 Outline of EoW criteria

Following the JRC methodology guidelines[43], it has been found that the following complementary elements should be combined in a set of end-of-waste criteria:

1. Product quality requirements
2. Requirements on input materials
3. Requirements on treatment processes and techniques
4. Requirements on the provision of information
5. Requirements on quality assurance procedures

The array of possible end-of-waste criteria that could be part of a proposal are presented individually below, with explanations that were partially derived from discussions held with the technical working group in the 2008 case study on compost.

The possible criteria presented below have been discussed with the technical working group, and have been adjusted and refined using the written inputs to the First Working document, and the discussions of the Workshop of 2 March 2011.

4.3 Product quality requirements for compost and digestate

Product quality criteria are needed to check:

(1) For elements that can result in direct environmental and health risks, and
(2) That the product is suitable for direct use (on land, for production of growing media, etc).

Product quality requires that compost or digestate is an adequate alternative to primary raw-materials and that substances or properties limiting or jeopardizing its usefulness have been effectively separated or eliminated. This refers to the usefulness both in the short term (one season, one year) and in a long-term perspective that considers several years and the progressive potential accumulation of harmful elements in soil.

Direct quality criteria on compost/digestate should include the following parameters:

(1) Quantitative minimum limits of elements providing a soil improvement/fertilising function, such as organic matter content, or nutrient (N, P, K, Mg) content.
(2) Quantitative maximum limits on elements potentially toxic to human health or ecotoxic, such as heavy metals, or persistent organic pollutants.
(3) Quantitative maximum limits on macroscopic foreign materials (e.g. glass, plastics, metals)

(43) End-of-waste documents from the JRC-IPTS are available from http://susproc.jrc.ec.europa.eu/activities/waste/. See in particular the operational procedure guidelines of Figure 5 in the "End-of-Waste Criteria" report.

(4) Limited content of pathogens (if appropriate through quantitative maximum limits)
(5) Limited presence of viable weeds (if appropriate through quantitative maximum limits)
(6) Minimum stability (if appropriate through quantitative maximum limits, but this parameter can also be controlled through other type of criteria such as a temperature-time profile, as part of the processes and techniques requirements).

When the mentioned parameters need to be quantified, the criteria should include requirements on how each of the parameters has to be tested. These testing requirements can be generic, allowing a degree of freedom within a framework of minima, or if found appropriate, be specific and refer to e.g. existing testing standards.

The different requirements that could be part of the product quality criteria were first identified for compost in the pilot study (IPTS, 2008). They are maintained as a base for this document following the support received from the Technical Working Group during the Stakeholder consultation in December 2010 and the discussions at the first workshop in Seville (2 March 2011). It was also agreed that they can straightforwardly be extended to digestate. The requirements are recalled below:

Criteria	Explanations	Reasons
<u>**Product quality requirements:**</u> (1) minimum organic matter content (2) minimum stability (3) no content of pathogens to an extent that poses health risks (measured by the absence of certain indicator organisms such as salmonellae) (4) limited content of viable weeds and plant propagules (5) limited content of macroscopic impurities (6) limited content of heavy metals and persistent organic compounds	One set of product quality requirements shall be developed and be valid for most uses, as it is not the role of the EU end-of-waste criteria to regulate specific uses. The criteria shall ensure that the quality of compost/digestate is high, as reflected in the existence of a market and a demand for the material, which shall be fit for most uses. Rules on compost/digestate use for very specific purposes and in specific geographical areas may demand even stricter product quality requirements than those included in the end-of-waste criteria, on the grounds of environmental protection, e.g. organic farming, or use on soil above water extraction	The product quality requirements serve to exclude composts/digestates from end-of-waste that: o have a low quality and therefore a too weak market demand o do not fulfil the technical requirements for the most important use purposes, or that in a dominating part of the compost/digestate market do not meet the existing legislation and standards applicable to products o are likely to have an overall adverse environmental or human health impact. More specifically: A minimum level of organic matter content is needed to ensure value, basic usefulness, as well as to prevent dilution with inorganic materials. A minimum stability is needed to avoid methane and odour emissions during uncontrolled anaerobic conditions after sales (e.g. during storage).

Criteria	Explanations	Reasons
	aquifers. The development of stricter requirements for such specific uses is not within the scope of end-of-waste criteria.	Limitation of macroscopic impurities is needed to ensure usefulness and to limit the risks of injuries. Limitation of pollutant concentrations is needed: o to ensure that the material's inherent risks are sufficiently low so that the environmental impacts in the case of misuse are within acceptable limits o to exclude end-of-waste composts/digestates that cannot be used lawfully for the main purposes in a dominant part of the compost/digestate market o to promote higher compost/digestate quality and as a signal against relaxing quality targets for compost/digestate production.

The proposal for the actual limits of the parameters to be regulated in the product quality requirements, in the table below, is based on the compost pilot study (IPTS, 2008) with the rationale for setting the values detailed in Annex 12 and following the two stakeholder consultations in December 2010 and April 2011. The necessary adaptations for digestate have been implemented as well.

The stakeholder survey of December 2010 yielded a number of alternative approach suggestions for setting limit values, such as using the strictest values existing in a Member State or setting more lenient values based on a risk assessment of metal uptake by crops. Whereas many approaches hold certain merits, their value is limited by the fact that they generally tend to focus on one specific end-of-waste condition, and are less relevant with regard to other conditions. For example, introducing more lenient limits for heavy metal values may still guarantee acceptable human health impacts, but risks to neglect ecological impacts or can even lead to a collapse of the compost market due to a declined consumer confidence. Conversely, setting stricter heavy metal limit values can provide a strong barrier against soil pollution in sensitive areas. Yet at the same time, such strict limits may reduce the amounts of compost/digestate that can reach EoW status and hence slow down market development and recycling rates in the EU, whereas the same soil protection goals could be realized by national regulations on the application of compost/digestate in such sensitive areas.

During the discussions at the first workshop on 2 March in Seville and following the stakeholder consultation in April 2011, proposals were made for various minimum quality requirements for compost and digestate.

Requirements that received large support for **compost** were:

- A minimum organic matter content. A minimum value of 15% on dry weight was greatly supported, as the initially proposed value of 20 % from the First Working Document was estimated to be too high. A minimum concentration of 15% is necessary as a protection threshold against organic manufactured mineral soils, which may contain high quantities of clayey materials. At the same time, it allows for materials with low natural organic matter such as green compost or very mature compost.
- A minimum stability. A minimum stability can avoid transport and storage problems of biologically active material due to further degradation. Furthermore, such a criterion could help avoid that materials with relatively high concentrations of pollutants may just pass the criteria. The latter is explained by the fact that when organic matter further degrades the total mass of compost will decrease and hence the pollutant concentration will increase with increasing maturity. At the same time, the necessity for a standardized testing method was emphasized. One proposal was the self heating test for compost according to prEN 16087-2:2010, in which case the result interpretation remained unclear. Hence for compost, a concrete proposal is the oxygen uptake rate, according to pr EN 16087-1:2010, with a maximum value of 15 mmol O_2/kg organic matter/hr.
- Pathogens: E. Coli and Salmonella were indicated as the most important pathogen indicator organisms. There was large support for the criteria 1000 CFU/g fresh mass for *E. Coli* and no *Salmonella* spp. in 50g of sample, which exist already in many national specifications. Most stakeholders supported the idea of having a pathogen criterion parallel to a criterion of a time-temperature profile.
- Viable weed seeds: there was large support for the criterion of maximum 2 viable weed seeds per litre of compost.
- Macroscopic impurities: here it was proposed to modify the original proposal of impurities (0.5% on dry matter base) into a more clear formulation of glass, metal and plastics. Stones should not be seen as a man made contamination and do not pose an environmental or health risk, and it appears to be more appropriate to regulate their content through market mechanisms. Large support was received for 0.5% on dry matter base for glass, metal and plastics > 2mm. A suggestion was made to introduce a requirement on the absence of sharps, to avoid any injuries upon manipulating the compost. Introducing the latter requirement may be hampered by the fact that a standard measurement method does not exist at present, and that this could lead to liability issues between producers and buyers of compost.
- Heavy metal values. There were both requests for increasing and lowering heavy metal limit values from the initial proposal in the First Working Document. A number of arguments were put forward, such as the fact that some metals are trace elements or that EoW criteria should not limit the metal limits as it is the total metal load to the soil that is important, i.e. the concentration times the compost amount applied. Control of the applied compost quantity, however, falls outside the competences of end-of-waste regulations and could easily lead to intentional or unintentional misuse. Overall, taking into account the 4 basic conditions of the EoW status, a majority of responses converged towards the initially proposed heavy metal values.
- Finally, a majority of stakeholders was not in favour of including organic pollutant parameters as long as the input consisted of source separated materials, for the sake of simplicity and cost-effectiveness of compost production, especially for small scale compost producers. It was argued that if mixed solid waste, sewage sludge or possibly contaminated input streams were to be allowed, strict criteria on organic pollutants would need to be introduced.

During the stakeholder consultation, less feedback was received regarding digestate product quality requirements. However, those stakeholders providing input on digestate generally had a positive attitude towards setting EoW quality criteria for digestate, supporting existing standards such as the UK PAS 110, Swedish SPCR 120 or German RAL GZ 245, or proposing similar quality requirements.

In general, there was also a tendency to have EoW product quality criteria for digestate in line with those for compost whenever possible. This should avoid that input streams that exhibit a somewhat higher contamination would be transferred from one treatment option to another.

The following requirements received clear support for **digestate**:

- Minimum organic matter content: Generally, digestates are less likely to contain large amounts of inorganic material due to the nature of the input materials used and there is little tendency of mixing digestate with inorganic materials prior to use. In order to be in line with the requirements for compost, a value of at least 15% on dry weight is proposed.
- Minimum stability: Given that the anaerobic digestion process is intrinsically different from the aerobic composting process, other post-process stability criteria are needed for digestate than for compost. Criteria based on organic acid contents received most support. A proposed value would be maximum 1500 mg organic acids (total) per litre digestate. It must be noted, however, that no international standard seems to exist at present for assessing this parameter.
- Pathogen control: Here the same values as for compost are clearly supported: 1000 CFU/g fresh mass for *E. Coli* and no *Salmonella* spp. in 50g of sample. Some suggestions were made to test for Plasmodiophora brassicae, tomato seeds and Salmonella Senftenberg W_{775}.
- Viable weed seeds: Here as well support was received for the criterion of maximum 2 viable weed seeds per litre of digestate.
- Macroscopic impurities: In line with the compost requirement, it was proposed to split the impurities in a glass, metal and plastics fraction and a stone fraction. General support was also received for 0.5% on dry matter base for glass, metal and plastics > 2mm.
- Heavy metal values. Some stakeholders argued that certain heavy metal limit values should be increased, in particular those for Cu and Zn, as these are considered to be micronutrients necessary for plant growth and are encountered in relatively elevated concentrations in digestate derived from manure as input material, originating from cattle feed and hoof disinfection liquids. Nevertheless, increasing heavy metal limit values in digestate could lead to the general use of more contaminated input materials and should therefore be approached with caution. Hence, at present it is proposed to have heavy metal values for digestate in line with those for compost.

In conclusion, this leads to following set of proposed criteria **for compost and digestate**

Parameter	Value	Comments
(1) Minimum organic matter content:	15% on dry matter weight	The minimum organic matter content of the final product, after the composting/digestion phase and prior to any mixing with other materials. This is intended to prevent dilution of compost/digestate with mineral components (e.g. sand, soil).
(2) minimum stability	For compost: 15 mmol O_2/kg organic matter/hr For digestate: 1500 mg organic acids (total) per litre digestate	The stakeholders agreed that this parameter shall be limited by a method for which a standardized test exist.
(3) no content of pathogens	No *Salmonella* sp. in 50 g sample 1000 CFU/g fresh mass for *E. Coli*	Measurement of this parameter should be complemented by a requirement on processing, e.g. a temperature-time profile, based on stakeholder input
(4) limited content of viable weeds and plant propagules	2 viable weed seeds per litre of compost/digestate	Measurement of this parameter should be complemented by a requirement on processing, e.g. a temperature-time profile, based on stakeholder input
(5) limited content of macroscopic impurities	0.5% on dry matter weight for glass, metal and plastics > 2mm	There is a need to distinguish between natural impurities such as stones and manmade impurities.
(6) limited content of heavy metals and persistent organic compounds:	mg/kg (dry weight)	In the final product, just after the composting/digestion phase and prior to any mixing with other materials
Zn	400	
Cu	100	
Ni	50	
Cd	1.5	
Pb	120	
Hg	1	
Cr	100	
No requirement to measure organic pollutants		Measurement of organic pollutants is not deemed necessary when applying a strict positive list of input materials excluding sewage sludge, mixed solid waste or possibly contaminated streams

<u>Requirements on product testing for compost and digestate</u>

Following stakeholder consultation, it appeared that only a minority of stakeholders was in favour of imposing a detailed frequency scheme for the analysis of compost or digestate samples in the frame of the End of Waste requirements. It is generally supported that the measurement frequency should be established depending on the size of the compost or digestate producing plant and be done in accordance with the regulatory authorities, allowing for a reduction in measurement frequency for those parameters that repeatedly are far below the limit values.

Regarding the testing methods to be used, there is large support for using EU-wide harmonized standards, especially those developed in the CEN Horizontal Project, which were developed in view of a wide range of materials, or those mentioned in the Quality Assurance Quality Manual of the European Compost Network.

There is also clear agreement on the requirement for external, accredited and independent sampling.

<u>Requirements on product testing</u> (sampling and analysis): **Compost and digestate producers must demonstrate by <u>external independent testing</u> that there is a sufficiently high probability that any consignment of compost/digestate delivered to a customer complies with the minimum quality requirements and is at least as good as the properties declared.** **The details of the sampling programme may be adjusted to the concrete situation of each compost/digestate plant. The competent authorities will, however, have to check compliance with the following requirements:** • **The compliance testing has to be carried out within <u>external, independent quality assurance</u> by laboratories that are <u>accredited</u> for that purpose** • **The CEN/Horizontal standards for sampling**	In the case of metal concentrations, the probability that the mean value of the concentration in a sample exceeds the legal limit should be less than a certain percentage (a confidence level of 95 % is typically used). This implies that the mean concentration of the whole population of the compost/digestate sold plus the confidence interval needs to be below the legal limit. (Usually, it will be impractical to sample from the total population and a subset of the overall population that can be considered typical of the whole population will have to be defined as part of the quality assurance process. Usually, the population will correspond to all the compost/digestate sold from a composting plant throughout a year or shorter periods of time). The scale of sampling needs to be chosen depending on the sales/dispatch structure of a composting/digestion plant.	A high level of environmental protection can be achieved only if there is reliable and comparable information on the environmentally relevant product properties. Claims made on product properties must correspond closely to the 'real' properties, and the variability should be within known limits. To manage compost/digestate so that environmental impacts and risks are kept low, it must be possible for compost/digestate users and regulatory authorities to interpret the declared product properties in the right way and to trust in conformity. Therefore, standardisation of product parameters, sampling and testing is needed as well as quality assurance.

and analysis have to be applied as far as available. See Annex 13 for a list of standards and sampling and testing methods. • **Probabilistic sampling should be chosen as the sampling approach and appropriate statistical methods used in the evaluation of the testing.**	The scale should correspond to the minimum quantity of material below which variations are judged to be unimportant. The better the precision of the testing programme (the narrower the confidence interval), the closer the mean concentrations may be allowed to be to the legal limit values. The costs of a testing programme of compost/digestate with very good quality (parameter values far from the limits) can therefore be held lower than for compost/digestate with values that are closer to the limit. When a new compost/digestate plant is licensed there is usually an initial phase of intensive testing to achieve a basic characterisation (for example one year) of the compost/digestate qualities achieved. If this proves satisfactory, the further testing requirements are then usually reduced.	

4.4 Requirements on input materials

The purpose of criteria on input materials is to check indirectly the quality of the material.

Two main options exist, and were discussed with the technical working group. One option is that the input material criteria allows most input sources, and only limits the materials in them that pose a specific environmental, health or quality concern if not treated adequately, or limits specific input sources. This is defined as the *negative list* approach. The second option is to list in detail the types of input materials that are preferred because their origin ensures absence or minimisation of risks, for instance a requirement that only garden and park waste from separate collection were accepted for EoW. The latter is defined as the *positive list* approach.

A positive list approach bears the risk of letting aside suitable sources of biodegradable waste, or sources which can become suitable as new technologies become available. Negative lists bear the concern of not excluding all potentially unsuitable materials.

Following discussion during the first workshop in March 2011 and subsequent stakeholder consultation in April 2011, it emerged that the vast majority of stakeholders supports the application of a positive list to define input materials for compost.

Annex 9 is generally indicated as an acceptable standard list. However, remarks were made that some waste codes are vague and need to be specified. Hence it should be stressed that the description in the first column should be predominant when judging the suitability of a certain input material, and the EWC code that is referred to in the 4th column only provides an indication of the most suitable corresponding EWC definition.

It was also proposed that a mechanism should be put in place in order to allow for an update of the positive list.

The following decisions seem to receive agreement for **compost**:

- Micelles from antibiotics production (1.4.02): can only be allowed if no antibiotics are present
- Municipal waste: other fractions not otherwise specified (1.4.07): EXCLUDE
- Silage leachate water (1.4.09): include
- Off-speciation compost (1.4.15): include only if compost is derived from materials coming from the positive list, so that it does not imply the content of any undesired input material
- Liquor/leachate from a composting process (1.4.16): include only if material is coming from same plant
- Liquor from anaerobic treatment of municipal waste (1.5.02): include only if anaerobic treatment is using materials coming from the positive list
- Muncipal sewage sludge (3.01): EXCLUDE
- Municipal solid waste- not source separated (3.03): EXCLUDE

The following decisions seem to receive agreement for **digestate**:

- Micelles from antibiotics production (1.4.02): EXCLUDE (not relevant for anaerobic digestion)
- Municipal waste: other fractions not otherwise specified (1.4.07): EXCLUDE
- Silage leachate water (1.4.09): include
- Off-speciation compost (1.4.15): EXCLUDE (not relevant for anaerobic digestion)
- Liquor/leachate from a composting process (1.4.16): include only if from same plant
- Liquor from anaerobic treatment of municipal waste (1.5.02): include only if anaerobic treatment is using materials coming from the positive list
- Muncipal sewage sludge (3.01): EXCLUDE
- Municipal solid waste- not source separated (3.03): EXCLUDE

Moreover, there was large support to include manure (already in the list as item 2.2.07) and renewable primary products such as energy crops for compost and digestate, as long as the composting or digestion process is considered as a waste treatment operation. The rationale behind this decision is that good quality materials containing primary products would otherwise not be able to receive the product status and hence their continued waste status would hinder them in the competition with End of Waste products. However, it must be emphasized that this document does not consider materials that could be regarded as by-products of an industrial process.

In general, stakeholders favour that it should be mentioned in large terms what the compost or digestate is made of (e.g. green waste or biobin waste) without the need to detail every input material present. For other types of compost or digestate that fall out of a certain general category, any specific material present in a quantity of more than 5% of the initial weight should be declared. Furthermore, it should be clearly indicated whether any animal by-products are present in the produced material.

The stakeholders commonly agreed that additives should only serve to improve the composting or digestion process, or improve environmental performance of the process. Certain metal compounds for instance can improve the biogas formation in the digestion process.
Additives that are used to increase the usefulness or economical value of the product, such as fertilizers, should be added *after* the product receives End of Waste status.

Changes that are proposed to the additives list (Item 4 in Annex 9) are:

- For **compost**, following additives should be added:
    - Commercial inoculants for composting
    - Bio-dynamic compost preparations

- For **digestate**, following additives should be added:
    - Iron salts
    - Iron oxides
    - Iron hydroxides
    - Magnesium salts
    - Aluminium salts up to 0.1 % fresh matter

For dewatered digestate, organic polymers should be allowed to be in the product, as they are needed for the mechanical dewatering operation. However, it should be clarified in more detail what kind of polymers can be allowed or not (e.g. anionic or cationic polymers from a certain monomer).

Furthermore, the stakeholders agreed that visual inspection of the input materials is the method of control for compost indeed. In order to allow control of origin and type of material, it may be desirable to only allow one certain kind of input material, rather than mixes. Regarding digestate, it is mentioned that visual inspection of liquid input material may be difficult and dangerous to workers. Such material may be transported in container trucks that only have small openings for control or release of the material. As such, visual inspection may be hampered by a lack of visibility or by the fact that toxic gases (e.g. H_2S) escape upon opening the sampling hatch. In this case, it is proposed that samples are taken of the input materials, which should be stored and can be analyzed in case of doubts or issues with the quality of the output material.

As long as a positive list is used, all input materials should be allowed without restrictions according to the stakeholder feedback.

Criteria	Explanations	Reasons
<u>Clean, biodegradable wastes are the only wastes allowed to be used as input materials</u> for the production of end-of-waste compost and digestate. **Annex 9 lists biodegradable wastes that are currently regarded as suitable for composting in one or more Member States.** **Following amendments are proposed:** **Micelles from antibiotics production (1.4.02): can only be allowed if no antibiotics are present** **Municipal waste: other fractions not otherwise specified (1.4.07): EXCLUDE** **Off-speciation compost (1.4.15): include only if compost is derived from materials coming from the positive list; this item is not relevant for digestate** **Liquor/leachate from a composting process (1.4.16): include only if material is coming from same plant** **Liquor from anaerobic treatment of municipal waste (1.5.02): include only if anaerobic treatment is using materials coming from the positive list**	Non-biodegradable components that are already associated with biodegradable waste streams at source, should, however, be allowed if they are not dominant in quantity, do not lead to exceeding the pollutant concentration limits (see product quality requirements) and do not impair the usefulness of the compost/digestate. Example: soil-like material attached to garden waste.	Composting and digestion is suitable as treatment only for biodegradable wastes. Dilution of other wastes with biodegradable waste needs to be avoided.

Criteria	Explanations	Reasons
Muncipal sewage sludge (3.01): EXCLUDE **Municipal solid waste- not source separated (3.03): EXCLUDE** **Primary raw materials should be allowed as well as input materials as long as the composting/digestion operation considers a waste treatment process.**		
The <u>input materials</u> used for the production of end-of-waste compost/digestate must be known by the producer. **It shall be indicated on the product what the material is based on, <u>in large terms</u>, using the definitions** • **Separately collected biowaste from households** • **Garden and park waste** • **Agricultural waste** • **Food industry waste** • **Other input materials (any specific material present in a quantity of more than 5% of the initial weight should be declared)** **It should be indicated**	The waste classification of the European Waste Catalogue should be used, ideally together with additional specifications, such as in the waste list in Annex 9.	Transparency on the input materials is important for the confidence of users in compost/digestate quality and can therefore strengthen compost/digestate demand. The information on the input material is needed to allow the use of compost/digestate in compliance with existing legislation. For example, the Community legislation of organic farming has specific rules for the use of compost from source-separated household waste. The restriction of input to source segregated material is considered current best practice in compost production. It has been demonstrated that concentrations of the relevant metals and of persistent organic pollutants in these waste types are robustly low enough for the production of high-quality composts (IPTS, 2008) If animal by-products were input, compliance with the Animal By-products Regulation ([44]) is required. Furthermore, users, for instance farmers, often wish to know the origins

([44]) Regulation (EC) No 1069/2009 of the European Parliament and of the Council of 21 October 2009 laying down health rules as regards animal by-products and derived products not intended for human consumption and repealing Regulation (EC) No 1774/2002 (OJ L 300, 14.11.2009, p. 1-33).

Criteria	Explanations	Reasons
whether any <u>animal by-products</u> have been used to produce the material.		and source materials of compost/digestate.

<u>Additives</u> (material other than biodegradable waste) can only be used when these are listed on the positive list
 	
Amendments proposed to the additives list in Item 4 of Annex 9 are:
• **For compost:**
  o **Commercial inoculants for composting**
  o **Bio-dynamic compost preparations**
 	
• **For digestate:**
  o **Iron salts**
  o **Iron oxides**
  o **Iron hydroxides**
  o **Magnesium salts**
  o **Aluminium salts up to 0.1 % fresh matter**
  o **Organic polymers used for dewatering in the case of dewatered digestate**
	Additives should only serve to improve the composting or digestion process, or improve environmental performance of the process	Additives can be used as input to the composting/digestion process in minor quantities, if they improve the compost/digestate quality or they have a clear function in the composting/digestion process and the metal concentrations (based on dry matter) do not exceed the concentration limits for end-of-waste compost/digestate.
		
		In practice, additives are sometimes needed to improve the composting/digestion process or the compost/digestate quality.

Suitable procedures for controlling the quality of input materials need to be followed by the operators of composting/digestion plants. **<u>Visual inspection is the method of choice to control input materials</u>**	It is agreed that in many cases visual inspection and approval of origin will be suitable procedures. In order to facilitate visual inspection, mixes of input materials in one	Controlling the input materials is a key factor (probably the single most important) for assuring reliable quality of the compost or digestate. Control of input covers also avoidance of mixing with other wastes not listed in the positive list.

Criteria	Explanations	Reasons
for compost and digestate. **When visual inspection would entail <u>health or safety risks, as in the case of liquid input materials, visual inspection shall be replaced by sample taking and storage for possible analysis.</u>** **See also section on criteria regarding quality control procedures.**	delivery should be banned. Visual inspection of liquid materials in containers or bulk trucks may be dangerous due to the escaping gases or difficulties in approaching the material. In such cases, samples should be taken	

4.5 Requirements on treatment processes and techniques

The purpose of introducing requirements on processes and techniques is to check indirectly product quality.

Apart from biodegradable waste which is directly used before collection (e.g. home composting), biodegradable waste is collected in varying quantities, processed and eventually may become compost/digestate used on soil or other purposes. Biodegradable waste may need sorting and removal of undesired components. Some very clean homogeneous sources may need transport and simple shredding without contact to other waste fractions, before composting/digestion, while others may need thorough sorting after collection.

Without pre-judging the point in the treatment chain where end-of-waste is reached, the purpose of the introduction of process requirements is to define minimum treatment conditions which are known to result in quality suitable for EoW in all cases. When reaching end-of-waste status, the material must have undergone those minimum necessary treatment processes that make it fit for marketing and use. The treatment processes must also ensure that transporting, handling, storage (loose or packed), trading and using compost/digestate takes place without increased environmental and health impact or risks.

The required treatment processes to achieve this differ depending on the waste streams from which the compost/digestate has originally been obtained. The criteria on processes and techniques can include:

- basic general process requirements that apply to all types of waste inputs;
- specific process requirements for specific types of waste inputs.

Generic requirements that do not prescribe a specific collection scheme, origin, type of operator (municipal/private/local/global) or technology are preferred, since industry and authorities in the biodegradable waste recycling chain should not be prevented from adjusting processes to specific circumstances and from following innovation. However, restrictions may be justified if it is proved that e.g. a given collection scheme or treatment systematically is not able to meet the standards required by the quality criteria.

From the stakeholder consultation, it emerged that nearly all stakeholders are in favour of imposing both an indicator organism product quality criterion and a time-temperature profile as they offer complementary advantages. Organism testing may e.g. reveal inferior mixing during the process whereby only a certain part of the material was exposed to the correct time temperature profile, leading to insufficient hygienisation. On the other hand, time temperature profiles allow monitoring the hygienisation process in real time and hence allow to react quickly in case of possible process irregularities that could lead to inferior hygienisation of the compost batch.

For **compost**, the proposed time temperature profiles from the first working document were generally supported, whereby following remarks were made:

- Animal by-products regulations should remain fully applicable for any material containing animal by-products
- Member States should be allowed to grant authorization for other time-temperature profiles after demonstration of their effectiveness for hygienisation.
- Mixing of the compost at regular time intervals should be done to ensure homogeneity of the process and to make sure aerobic conditions prevail at all times, especially for composts with considerable fractions of small particles.

For **digestate**, only a few time temperature profiles have been proposed upon stakeholder consultation. A reasonable proposal was a time temperature profile of 55 °C during at least 24h and a hydraulic retention time of at least 20 days, otherwise either the input materials or the output material should receive an additional treatment step at 70 °C.

The following measures were proposed to avoid cross-contamination:

- Plants that produce End of Waste compost or digestate should only be allowed to process approved materials from the positive list.
- In the case of using animal by-products, separate storage is required to avoid cross-contamination with non animal by-product containing materials.
- The possibility of physical contact between input materials and final products must be excluded.

The proposed criteria on treatment processes and techniques for **compost and digestate** include:

Criteria	Explanations	Reasons
It must be demonstrated for each compost/digestate batch that a suitable <u>temperature-time profile</u> was followed during the composting/digestion process for all material	The desired risk control can be achieved, avoiding being overly descriptive, by allowing a number of alternative temperature-time profiles from existing standards or regulations. The	As is common in existing regulations and standards, there should be process requirements to ensure that the processes yield composts and digestates without hygienic risk.

(45) Regulation (EC) No 1069/2009 of the European Parliament and of the Council of 21 October 2009 laying down health rules as regards animal by-products and derived products not intended for human consumption and repealing Regulation (EC) No 1774/2002 (OJ L 300, 14.11.2009, p. 1-33).

Criteria	Explanations	Reasons
contained in the batch. **Annex 10 lists temperature-time profiles required by the Animal By-products Regulation ([45]) and national legislation and standards for composting plants. Based on the list in Annex 10, a set of three allowable time-temperature profiles could be proposed for <u>materials subject to composting and not including and animal by-products</u>:** **65 °C or more for at least 5 days** **60 °C or more for at least 7 days** **55 °C or more for at least 14 days** **In the case of anaerobic <u>digestion for materials not containing any animal by-products</u>, a time temperature profile of 55 °C during at least 24h and a hydraulic retention time of at least 20 days should ensure complete hygienisation.** **<u>Member States</u> should be allowed to <u>grant authorization for other time-temperature profiles after demonstration of their effectiveness</u> for hygienisation.** **<u>Animal by-products regulations should remain fully applicable</u> for any compost or digestate material containing animal by-products**	producer must comply with at least one profile that has been approved as suitable for the type of composting process applied and is specified in the licence/permit by the competent authority. It must be ensured that all of the material undergoes appropriate conditions. Depending on the process type this may require, for example, suitable turning, oxygen supply, presence of enough structural material, homogenisation, etc.	

Criteria	Explanations	Reasons
In order to avoid cross-contamination, following measures should be respected: **Plants that produce End of Waste compost or digestate should <u>only be allowed to process approved materials from the positive list</u>.** **In the case of <u>using animal by-products, separate storage</u> is required to avoid cross-contamination with non animal by-product containing materials.** **The possibility of <u>physical contact between input materials and final products must be excluded</u>.**	Apart from ensuring correct processing conditions during composting/digestion, cross-contamination needs to be minimized.	Cross-contamination can cause a carefully produced material to pose quality problems and/or environmental or health concerns.

4.6 Requirements on the provision of information

Requirements on the provision of information are a complementary element of end-of-waste criteria. The criteria have to minimise any onerous administrative load, recognising when current practice is competent in providing a valuable material for recycling, respecting existing legislation, and protecting health and the environment.

The provided information should also demonstrate that compost or digestate is an adequate alternative to primary raw-materials.

Not only could the provided information mention the actual levels of those parameters that are bound by limits. The criteria could also require the declaration of additional parameters related to the fitness of the material for use, such as content of alkaline effective matter, pH, grain size, density, or water content.

When the mentioned parameters need to be quantified, the criteria would likely include requirements on how each of the parameters has to be tested. These testing requirements can be generic, allowing a degree of freedom within a framework of minima, or if found appropriate, be specific and refer to e.g. existing testing standards.

The formulation of end of waste criteria shall aim to be as simple as possible, for clarity, and easier communication and implementation. In the pursue of this aim, the included parameters shall be the minimum strictly necessary to fully characterise the completeness of treatment of compost/digestate, while ensuring that the material is fit for a safe use in the different potential outlets.

Following the stakeholder consultation, it emerged that the list of parameters to declare, as proposed in the first working document, was generally supported. The list largely corresponds to the list established in the ECN-QAS Quality Manual, with a few exceptions (e.g. mineralisable nitrogen content), and which is already known to and supported by many stakeholders.

For digestate, the same list received support, with just one modification. Given the more pronounced use as a nutrient source, compared to compost, the sulphur content should be added as well.

The different requirements that could be part of the criteria regarding provision of information for **compost and digestate** are presented below:

Criteria	Explanations	Reasons
Declaration of the following parameters (product properties) when placing <u>compost/digestate</u> on the market: **Usefulness concerning soil improving function:** **• Organic matter content** **• Alkaline effective matter (CaO content)** **Usefulness concerning fertilising function:** **• Nutrient content (N, P, K, Mg) and also S in the case of digestate** **• Mineralisable nitrogen content (NH4-N, NO3-N)** **Biological properties:** **• Stability/maturity** **• Plant response** **• Contents of germinable seeds and plant promulgates** **General material properties** **• Water or dry matter content** **• Bulk density/volume weight** **• Grain size** **• pH** **• Electrical conductivity (salinity)** **Hygienic aspects relevant for environmental and health protection** **• Presence of Salmonellae** **• Presence of E.coli**	The parameters to be included determine the usefulness of compost/digestate and the environmental and health impacts and risks of compost/digestate use.	Composts/digestates can be used as a safe and useful product only if the relevant properties of the material are known to the user and the corresponding regulatory authorities. This information is needed to adapt the use to the concrete application requirements and local use conditions as well as the corresponding legal regulations (e.g. the provisions on soil protection that apply to the areas where the compost/digestate is used). An adequate declaration of the material properties is therefore a prerequisite for placing compost/digestate on the market and for the waste status to be lifted.

Pollutants and impurities relevant for environmental and health protection **• Contents of macroscopic impurities (such as glass, metals, plastics)** **• Contents of some heavy metals and persistent organic compounds** (See also details in Annex 11 and 12)		

Labelling of compost and digestate may allow the consumer to judge about additional properties of the material that cannot be defined through a limited set of product quality criteria. It may also be a legal necessity in some cases, for instance to determine whether the EoW compost is suitable for use in organic farming or eligible for the production of growing media or soil improvers being rewarded with the Community eco-label.

The stakeholder consultation on this issue showed that many stakeholders indicated the need of the issuance of the statement of conformity.

Furthermore, there appears to be agreement that it should contain following elements:

- The name and address of the compost/digestate producer
- Compost/digestate designation identifying the product by general type
- Batch code
- Quantity (to be expressed by preference in weight or otherwise in volume)
- The parameters to declare through labelling
- A statement indicating that End of Waste criteria are met
- Product declaration in line with national regulations in the Member State where the material has been produced
- The conformity with national quality assurance requirements in the Member State where the material has been produced
- The conformity with End of Waste requirements
- The recommended conditions of storage
- A description of the application areas for which the compost/digestate may be used and any limitations on use
- Recommendations for the proper use

In addition to this, it was proposed to have a European-wide denomination for such materials, which is protected and can only be used for compost/digestate receiving end-of-waste status, although it is not clear how this can be justified by the 4 conditions for end-of-waste and how this should be implemented in practice.

Furthermore, it was agreed that recommendations on use of the product are very useful. However, distinction should be made between general recommendations and codes of good agricultural practice, on the one hand, and references to regional, national or EU-wide specific requirements, on the other hand.

Generally, the stakeholders argued that the aimed reduction of the administrative burden linked to the product status could be jeopardized by imposing extreme traceability demands on the compost/digestate receiving End of Waste status. Hence, traceability should stop at the producer stage, meaning that any direct buyer or user can trace back the compost/digestate to the producer and there should not be any obligation for the producer to track the final use of the compost/digestate.

The proposed criteria on requirements on the provision of information for **compost and digestate** include:

Criteria	Explanations	Reasons
When placing compost or digestate on the market, the producer must declare the following: **•The name and address of the compost/digestate producer** **•Compost/digestate designation identifying the product by general type** **•Batch code** **•Quantity (in weight and/or volume)** **•The obligatory parameter values** **•A statement indicating that End of Waste criteria are met** **•Product declaration in line with national regulations in the Member State where the material has been produced** **•The conformity with national quality assurance requirements in the Member State where the material has been produced** **•The conformity with End of Waste requirements** **•The recommended conditions of storage** **•A description of the application areas for which the compost/digestate can be used and any limitations on use** **•Recommendations for the proper use**	A use of compost/digestate can be considered as recognised only if there are suitable regulations or other rules in place that ensure the protection of health and of the environment. The applicability of such rules must not depend on the waste status of the compost.	It is a condition for end-of-waste that the product fulfils the technical requirements for a specific purpose and meets the existing legislation and good practice standards applicable to products. The producer could be requested to identify the legal norms that regulate the use according to the identified purposes in the markets on which the product is placed.

Criteria	Explanations	Reasons
The product should be accompanied by <u>instructions on safe use and application recommendations.</u> **The instructions should also make reference to the need of <u>compliance with any legal regulations, standards, and good practice applying to the recommended uses</u>.**	For example, instructions and recommendations may refer to the maximum amounts and recommended times, for spreading on agricultural land. Spreading and incorporation in soil e.g. have to follow good agricultural practice. At the same time, national or regional regulations may impose additional requirements, depending on e.g. the local soil conditions.	Application instructions and recommendations help to avoid bad use of the compost/digestate and the associated environmental and health risks and impacts. Reference to legal requirements and standards for use are intended to support legal compliance by the compost/digestate user. These instructions shall not be more burdensome than those required for products with the same function, e.g. peat or fertilisers.
<u>Traceability:</u> The information supplied to the <u>first buyer or user</u> together with the compost/digestate should allow the identification of the producer of the compost/digestate, the batch and the input materials used.	Member States may require users to keep records of these data for certain uses so that the compost/digestate can be traced back to the origin when needed.	For the event of environmental or health problems that can potentially be linked to the use of compost/digestate, there is a need to provide traceability trails for any investigations into the cause of the problems.

4.7 Requirements on quality assurance procedures (quality management)

Quality assurance is an element of end-of-waste criteria of importance because it is needed to establish confidence in the end-of-waste status.

The acceptance control of input materials, the required processing and the assessment of compliance with final quality requirements shall have been carried out according to good industrial practice regarding quality control procedures.

In this context, quality assurance is needed to create confidence in the quality control on the compost/digestate undertaken by its producer, and reliability on the end-of-waste criteria that distinguish consignments meeting EoW criteria from consignments that have not applied for or do not meet EoW criteria. The producer of the material applying the end-of-waste status will have to have implemented and run a quality assurance system to be able to demonstrate compliance with all the end-of-waste criteria, and use this as documentation when the material is shipped.

Both in the qualitative and quantitative EoW criteria that refer to procedures and process controls, it is considered essential that there is a quality management system in place which explicitly covers the key areas of operation and the quality of the final products where compliance with end-of-waste criteria has to be demonstrated.

One of the possible options to demonstrate compliance is having implemented and run an internationally recognised and externally verified quality management system such as ISO 9001 or a quality assurance scheme respecting certain provisions like the one operated by the European Compost Network. External verification is a compulsory element of these, and should assess if the quality management system is effective and suitable for the purpose of demonstrating compliance with the end-of-waste criteria.

A suitable quality management system for compost/digestate is expected to include:

- acceptance control of input materials based on a positive list;
- monitoring and record keeping of processes to ensure they are effective at all times;
- procedures for monitoring product quality (including external sampling and analysis) that are adjusted to the process and product specifics according to good practice;
- periodical third-party surveillance with quality control of compost/digestate analyses and on-site inspection of the composting/digestion plant inlcusive inspection of records and the plants' documentation
- plant certification for declaration and labelling of input materials, the product characteristics, the product type and the producer;
- information on conformity with national regulations, quality assurance and EoW standards and requirements of the competent authority
- measures for review and improvement of the plant's quality management system;
- training of staff.

For the competent waste authority, it must be able to commission an independent second party audit of the implemented quality management system to satisfy itself that the system is suitable for the purpose of demonstrating compliance with end-of-waste criteria.

In respect of the frequency of monitoring, the appropriate frequency for each parameter should be established by consideration of the following factors (see also section on product quality testing):

- the pattern of variability, e.g. as shown by historical results;
- the inherent risk of variability in the quality of waste used as input to the recovery operation and any subsequent processing;
- the inherent precision of the method used to monitor the parameter; and
- the proximity of actual results to the limit of compliance with the relevant end-of-waste condition.

Frequency of monitoring includes the number of times a parameter is monitored over any given time period depending on the plant treatment capacity so that it is a representative sample of the total. In the absence of historical results for any relevant parameter, it is good monitoring practice to carry out an intensive monitoring campaign over a limited period (e.g. less than 12 months) in order to characterise the material stream, thereby considering seasonal variations in composition. The results from this initial monitoring campaign should thus provide a basis for determining an appropriate longer term monitoring frequency.

The result of the monitoring frequency determination should subsequently provide a stated statistical confidence (often 95% confidence level is used) in the ultimate set of monitoring results. The process of determining monitoring frequencies should be documented as part of the overall quality assurance scheme and as such should be available for auditing. The detail on the verification, auditing or inspection of the quality assurance scheme can follow different national approaches.

Following stakeholder consultation, it was revealed that for compost the stakeholders generally supported the ECN-QAS system as the quality management system. For digestate, such a system is currently under development by the European Compost Network and stakeholders generally referred to national systems being set-up in some Member States.

It is generally proposed that sampling frequency should not be described by End of Waste regulations, but be part of the quality assurance scheme of the producing plants.

Stakeholders agree that independent bodies should verify the quality management system for producers of End of Waste compost/digestate.

The proposed requirements on quality management for compost and digestate are the following:

Criteria	Explanations	Reasons
Compost/digestate producers are required to operate a <u>quality management system</u> in compliance with quality assurance standards that are recognised as suitable for compost/digestate production by Member States or the Community. **It should include following elements:** **• acceptance control of input materials based on a positive list;** **• monitoring and record keeping of processes to ensure they are effective at all times;** **• procedures for monitoring product quality**	Recognised quality assurance standards for compost and digestate are set out, for example, in the British publicly available specification BSI PAS 100 (Compost) and 110 (Digestate), and the German BGK's RAL quality assurance system. Besides the national standards, the European Compost Network has established a quality management system for compost, which is widely supported. Furthermore, it is currently developing a similar system for digestates.	Users and the authorities that are in charge of controlling the use of the compost need to have reliable quality guarantees. Trust in the quality of the material is a precondition for a sustained market demand. The actual product properties must correspond well to what is declared and it must be guaranteed that the material minimum quality requirements as well as the requirements concerning the input materials and processes are actually met when a product is placed on the market.

Criteria	Explanations	Reasons
(including external sampling and analysis) that are adjusted to the process and product specifics according to good practice; • periodical third-party surveillance with quality control of compost/digestate analyses and on-site inspection of the composting/digestion plant inlcusive inspection of records and the plants' documentation • plant certification for declaration and labelling of input materials, the product characteristics, the product type and the producer; • information on conformity with national regulations, quality assurance and EoW standards and requirements of the competent authority • measures for review and improvement of the plant's quality management system; • training of staff		
The quality assurance system is audited externally by the competent authorities or by quality assurance organisations acknowledged by Member State authorities.		The reliability of product quality will be acceptable only if the quality assurance systems are audited by the authorities or an officially acknowledged third-party organisation.

4.8 Application of end-of-waste criteria

For the application of end-of-waste criteria laid out above it is understood that a consignment of compost/digestate ceases to be waste when the producer certifies that all of the end-of-waste criteria have been met.

It is understood that compost/digestate that has ceased to be waste can become waste again if it is discarded and not used for the intended purpose, and therefore fall again under waste law. This interpretation does not need be specifically stated in the EoW criteria, as it applies by default.

It is proposed that the application to EoW from a producer or importer refers to a statement of conformity, which the producer or the importer shall issue for each consignment of compost/digestate.

The producer shall transmit the statement of conformity to the next holder of the consignment. They shall retain a copy of the statement of conformity for a period of time to be defined (e.g. at least one year after its date of issue) and shall make it available to competent authorities upon request. The statement of conformity may be issued as an electronic document.

Following consultation, it emerged that the majority of stakeholders is not in favour of a demand that End of Waste compost or digestate loses its End of Waste status when it is not put on the market. There may be legitimate reasons for which these products are not put on the market, such as direct use of the product by the producer (e.g. in the case of on-farm composting whereby the produced compost is used on the own fields). Producers of compost or digestate using their own materials might still want to apply for End of Waste status in this case, as it demonstrates the quality of their process and material.

It was proposed to allow End of Waste status to materials that have fulfilled all criteria but are temporarily stored. However, the problem with the latter approach is that compost/digestate may undergo (biological) changes during medium to long term storage at the producer, or risks to be contaminated by other material. Hence the End of Waste status should only be granted upon transfer to the buyer or at the instant of use by the producer, given that all the criteria are met at that moment.

Furthermore, the initial proposal from the first working document of having to inform national authorities did not receive positive acclaim as it is feared that such obligation may lead to jeopardizing the advantages of the product status compared to the waste status. Strict End of Waste criteria should be the safeguard for environmental protection and the responsibility of the producer should end at the gate.

Hence, the proposed elements for the application of end-of-waste criteria for compost and digestate become the following:

Criteria	Explanations	Reasons
Compost/digestate ceases to be waste, provided all other		The end-of-waste criteria are defined so that compliant

Criteria	Explanations	Reasons
end-of-waste criteria are fulfilled, <u>when used by the producer or upon its transfer from the producer to the next holder</u>. However, if there is no final lawful use, compost/digestate will be considered waste.		compost/digestate can be stored and traded freely as a product once it is placed on the market by the producer. The benefits of the end-of-waste criteria are made actual if compost/digestate users are not bound by waste legislation (this means, for example, that farmers or landscapers using compliant compost/digestate do not require waste permits nor do formulators of growing media that use compost/digestate as a component). Users have, however, the obligation to use the product according to purpose and to comply with the other existing legislation and standards applicable to compost.
If the compost/digestate is mixed/blended with other material before being placed on the market, the product quality criteria apply to the compost/digestate before mixing/blending.		Meeting the limit values relevant for product quality by means of dilution with other materials should not be allowed.

5 Description of impacts

The establishment of end-of-waste criteria is expected to support recycling markets by creating legal certainty and a level playing field, as well as removing unnecessary administrative burden. This section outlines keys impact issues of the implementation of end of waste criteria on the environment, markets, and the application of existing legislation.

The impacts depend on how exactly end of waste criteria are formulated. However, as only a draft set of criteria is available at this stage, pending the outcome of discussions with the Technical Working Group, the impacts have been outlined based on the information found and/or provided by the experts so far, and have not yet been analysed in detail.

The completion of this section in detail will be undertaken on a more mature set of criteria, which is expected after the discussions with the Technical Working Group at the workshop of 24 and 25 October 2011. In the paragraphs below, the main elements to be addressed in the impact assessment are outlined, indicating the type of data needed.

5.1 Environmental and health impact

5.1.1 Climate change impacts of methane and other greenhouse gas emissions during the composting or digestion process, pretreatment and storage

Chapter 2.8 concluded that there were three main groups of environmental and health issues related to composting and digestion that needed to be managed:

1. Climate change impacts of methane emissions during the composting and digestion process, pre-treatment and storage

2. Local health and environmental impacts and risks at, and close to, the composting or digestion facility (linked to odour, gas emissions, leachate and pathogens in bioaerosols)

3. Soil, environment and health protection when using compost/digestate, especially when applying the material to land

The proposed end of waste criteria affect the first two groups only indirectly because they do not imply any change of the legal situation during composting or digestion.[46] Composting and digestion always has to be considered a waste treatment activity and as such is covered by waste regulatory controls.

[46] The only exception is methane emissions during storage of immature compost after sales. End of waste criteria in principle reduce the legal base on which the issue can be addressed. However, compared to the current situation, the proposed end of waste criteria would not make any significant difference, because methane emissions during storage of compost hardly receive attention by regulatory authorities today. In any case, if the issue were considered as crucial, a straightforward solution would be to include a minimum compost maturity/stability requirement in the end of waste criteria.

As an indirect effect of end of waste criteria, there is a good chance that the requirement to operate a quality management system will have a positive effect also on the management of the process related environmental impacts. Furthermore, if end of waste criteria induce changes in composting and digestion capacities and the amount of compost and digestate produced, this will also affect the compost production related environmental impacts, and those of the alternative waste treatment activities.

The exact size of these indirect effects, and their overall balance (positive or negative) can hardly be measured. In any case, the indirect effects of end of waste will not be decisive factors for the environmental impacts from composting or digestion facilities. A much more important legal development in this respect is the coverage of composting and digestion plants in the Industrial Emissions Directive ([47]). Composting plants with a capacity of more than 75 tonnes per day are covered in this directive, as well as anaerobic digestion plants with a capacity of at least 100 tonnes per day.

The third group of environmental and health impacts, however, are affected directly by end of waste criteria because end of waste criteria will alter in most cases the regulatory controls applicable to compost use and are also very likely to affect the quality of compost produced and used.

The proposed end of waste criteria have been designed in a way that rules out intolerable impact and risks to human health and the environment in absolute terms. The criteria include minimum compost and digestate quality requirements regarding sanitation, impurities and contents of hazardous substances. Furthermore, they stipulate that compost and digestate may cease to be waste only if placed on the market for purposes for which suitable regulation on compost use is in place to ensure environmental and health protection. There is, however, the possibility of relative changes of environmental impacts when comparing a "no action" scenario with a scenario where the proposed end of waste criteria are applied. As such, it should not be investigated what is the potential adverse environmental impact of the use of compost or digestate, but what is the impact of moving compost or digestate from a waste status to a product status and the different legislation it becomes submitted to.
Such relative changes, i.e. the *marginal* environmental impact, are assessed in this chapter.

Average contents of hazardous substances in compost and digestate

Hazardous substance concentration is a useful proxy indicator for the potential overall environmental impact of compost and digestate use because more benefit can be obtained from compost and digestate used at the same potential of negative toxicological and ecotoxicolgical impacts when concentrations of hazardous substances are reduced.

The overall environmental impact of compost and digestate use is determined by the balance of specific positive and negative impacts. The soil improving function of compost, for instance, has positive environmental impacts, such as reduced soil erosion and improved water retention. The main negative aspects are the potential toxicological and eco-toxicological impacts due to the contents of hazardous substances (mainly heavy metals and organic pollutants). A quantitative comparison of the positive and negative impacts of compost and digestate use in

([47]) Directive 2010/75/EU of the European Parliament and of the Council of 24 November 2010 on industrial emissions (integrated pollution prevention and control) (OJ L 334 17.12.2010, p. 17) the different scenarios (with and without end of waste criteria) is not practicable. However, it can be assessed if end of waste criteria are likely to lead to a change of the average concentrations of hazardous substances in compost and digestate used and produced in a country.

Referring to Table 9 in Annex 12, it can be seen that in most countries the end of waste criteria would introduce new quality standards for compost production that are stricter than the current lead standards. The same goes for the standards with regard to digestate. This is expected to lead to a reduced average concentration of hazardous substances, in particular heavy metals, in compost. An effective relaxation of the lead quality standards regarding the allowed concentrations of hazardous substances would only occur in the Netherlands. This might theoretically open the door for tolerating higher hazardous substance concentrations in compost production for exports. Since quantitative restrictions of compost use in the Netherlands are set by fertiliser law and independent of the waste status, end of waste criteria should however not alter the contents of hazardous substances of compost used in the Netherlands. A similar scenario is valid for Denmark, where current levels are set at 0.8 mg/kg for Cd and Hg, which are stricter than the EU ecolabel limits.

<u>Hazardous substance flows to soil</u>

A second way to compare the environmental impact of compost or digestate use with and without end of waste criteria, is to look at the size of the hazardous substance flows to soil associated with compost and digestate use. Hazardous substance flows are an indicator of the size of the potential ecotoxicologial and toxicological impacts of compost and digestate use. They are determined by the combined effect of changes in concentrations and of amounts of compost or digestate used.

While, as argued above, average concentrations are likely to decrease, it is more difficult to foresee how the total amount of compost and digestate used (both compliant and non-compliant with end of waste criteria) would be affected by end of waste criteria. An overall conclusion on the combined effect on hazardous substance flows is therefore not possible. It is likely, however, that there will be increased hazardous substance flows at certain locations where the quality of compost and digestate used is approximately the same with and without end of waste criteria and more compost and digestate will be used due to increased availability. However, since the end of waste criteria include minimum compost and digestate quality requirements and demand that there must be suitable locally applicable use rules, it can be expected that the overall environmental balance of increased compost and digestate use is still positive.

<u>Risks related to misuse of compost or digestate</u>

A third aspect to assess are the risks of environmental impacts (likeliness and size) because of compost or digestate misuse (not for recognised purpose or not complying with quantitative use restrictions). These risks may change when end of waste criteria lead to a new market situation (alterations in compost and digestate supply and demand) and affect the regulatory controls applicable to compost and digestate trade and use.

Locally, there may be increased risks related to compost and digestate misuse if end of waste criteria lead to new situations of oversupply, because of facilitated imports, that the market cannot handle efficiently. This theoretical possibility appears most relevant close to the main compost and digestate producing countries and where little experience exists yet with compost use. However, the heavy metal limits of end of waste criteria are set at a level that keeps any potential environmental impacts low even in the case of misuse. As a complementary measure to end of waste criteria it may be indicated that some countries put means in place for the monitoring of compost and digestate flows (e.g. registration and analysis of data of compost placed on the market) in order to detect and manage possible situations of oversupply.

Conclusion

Altogether, the overall environmental impact of compost and digestate use in the end of waste scenario is expected to be more positive or at least neutral than in the "no action" scenario, both at the EU level and at the level of individual Member States. There is the theoretical possibility of a locally less favourable balance at certain places but there are proportionate accompanying measures to detect and counter any undesired developments.

The existence and enforcement of adequate compost and digestate use rules is an important factor supporting the positive environmental balance of end of waste criteria, especially in countries where composting and/or digestion is not a common practice today.

5.2 Economic impact

Costs of compost and digestate production

The main potential cost factor of end-of-waste criteria for compost and digestate production is quality assurance in the case of composting or digestion plants where an upgrading of quality assurance is required. ORBIT/ECN (2008) produced an overview of quality assurance costs according to the main schemes in place in various countries for compost. Table 9 shows that the quality assurance costs are mainly determined by the size of the composting plant and range from below EUR 0.08/tonne of input to more than EUR 3/tonne of input. The costs measured per tonne of compost produced are about double these values. The quality assurance costs in Table 9 reflect the external expenses in the renewal procedure of certificates or quality labels during the continuous operation of the plants. In the first application and validation period (first one to two years) costs are considerably higher on account of a first evaluation of the plants and the higher frequency of tests. Additional costs are incurred through the internal staff requirements for operating the quality management system.

The total compost production costs in a best practice composting plant with 20 000 tonnes capacity were estimated at EUR 45/tonne of input (Eunomia, 2002). A comparison with the average quality assurance costs for a plant of this size according to Table 9 shows that the external quality assurance costs represent less than 1 % of total costs.

For open-air windrow composting the cost can be less than EUR 20/tonne. In this type of plant the throughput is usually much smaller and, in the case of 500 tonnes/year, quality assurance can make up more than 15 % of total costs.

Although for digestion, no specific cost information was received with regard to the quality assurance system, it can be reasonably assumed that the costs will be in the same order of magnitude as for composting, given that the same processes are followed and that analyses also cover similar parameters. Compared to the production cost of digestate (30 to 80 Euro/tonne), the weight of the quality assurance in the total production cost for digestion is similar to the one for compost.

However, many composting and digestion plants have already suitable quality assurance systems in place (at least one fifth of all composting plants in the EU), and most others regularly carry out some form of compliance testing, so that not all of the quality assurance costs associated with end-of-waste would be additive.

Table 9: Cost of compost quality assurance in selected European countries. Source: ORBIT/ECN (2008).

Quality assurance costs/tonne input and year (EUR excluding VAT)										
Throughput/ year (tonnes)	**AT (1) (ARGE) Agriculture plants**	**AT (2) (KGVÖ) Industrial plants**	**DE (3) (BGK)**	**IT (4) (CIC)**	**NL (5) (BVOR) (Green C. plants)**	**NL (6) (VA) (VFG plants)**	**SE (7) (SP)**	**UK (8) (TCA) Use in agriculture/ horticulture**	**UK (9) (TCA) Other uses**	**EU Mean value**
500	2.15	3.36	—	—	—	—	—	—	—	—
1 000	0.94	1.80	—	—	—	—	—	—	—	—
2 000	0.97	1.32	0.82	—	1.62	1.99	1.21	1.13	1.10	1.26
5 000	0.63	0.67	0.52	0.48	0.76	0.80	0.48	0.45	0.44	0.59
10 000	0.44	0.58	0.34	0.46	0.53	0.40	0.29	0.28	0.27	0.42
20 000	0.26	0.44	0.31	0.45	0.39	0.20	0.15	0.23	0.22	0.32
50 000	0.17	0.36	0.19	0.43	0.21	0.08	0.06	0.20	0.19	0.23

Sources: Personal information from:

(1) KGVÖ Compost Quality Society of Austria — operates mainly biowaste treatment plants. Costs include membership fees, laboratory costs and external sampling.

(2) ARGE Compost & Biogas Association Austria — decentralised composting of separately collected biowaste in cooperation with agriculture. Costs include membership fees, laboratory costs and external sampling.

(3) BGK German Compost Quality Assurance Organisation. Costs include membership fees, laboratory costs and external sampling.

(4) CIC Italian Compost Association CIC — including company fee according to turnover plus external sampling and laboratory costs

(5) BVOR Dutch Association of Compost Plants — costs at green waste plants which include membership fees, laboratory costs and the costs for yearly audits by external organisations — no external sampling.

(6) VA Dutch Waste Management Association — costs at biowaste (VFG) plants including membership fees, laboratory and external sampling costs, and the costs for yearly audits by external organisations. The expenses are slightly higher compared to BVOR because of additional analysis of sanitisation parameter and the external sampling.

(7) SP Swedish Standardisation Institute execute the QAS scheme — costs include membership fees, laboratory costs, and costs for yearly audits by SP — sampling is done by the plants besides the yearly audit.

(8) TCA the UK Compost Association certification for compost in agriculture and horticulture — total costs associated with certification scheme fees for all parameter and lab testing. Costs associated with testing the compost are higher compared to other application areas, as the compost producer is required to test parameters like total nutrients, water soluble nutrients and pH in addition sampling is done by the plants. For compost used in agriculture and field horticulture, the UK Quality Compost Protocol has introduced for the land manager/farmer the requirement to test the soil to which compost is applied. The costs associated with soil testing are not incorporated here because it is mostly not the compost producer, but the farmer or land manager who pays for.

(9) TCA the UK Compost Association certification for compost used outside agriculture and horticulture — total costs associated with certification scheme fees and lab testing. Sampling is done by the plants.

<u>Cost of compost and digestate use</u>

Users of end-of-waste compost and digestate need not comply with waste regulatory controls. Other legal obligations, for example based on fertiliser or soil protection law, are independent of waste status. There is also the possibility of new regulatory obligations being introduced as accompanying measures to end-of-waste criteria. The net difference of the cost of compost or digestate use in an 'end-of-waste scenario' compared to a 'no action scenario' depends therefore on the specific legal situation in each country and may even be different between regions of one country. It was not possible to get a full picture of compliance costs of compost use within the scope of this case study. However, the case of the compost quality protocol in the United Kingdom can serve as an example. The Composting Association (2006) estimated that for agricultural use of compost under the quality protocol (equivalent to end-of-waste) the agricultural compliance costs are reduced by EUR 1.69 (GBP 1.29 ([48]))/tonne of compost.

<u>Benefits</u>

Where end-of-waste criteria lead to an upgraded quality assurance it can, in principle, be expected that the compost or digestate will be of improved quality, rendering additional benefits to users, for instance agronomic benefits in the case of agricultural use. The size of these benefits, however, cannot be reasonably quantified within this study.

<u>Overall assessment</u>

Where quality certified compost or digestate is used today under waste regulatory controls, end-of-waste criteria are likely to lead to a net cost reduction. The cost reductions accrue in the use sector, and may possibly be transferred back to some extent, through the acceptance of increased compost and digestate prices, to compost and digestate producers, and through reduced gate fees to municipalities or other relevant waste generators.

Where the quality certification of compost and digestate needs to be upgraded for complying with end-of-waste criteria, this creates increased costs for compost and digestate producers, which are not likely to be very significant in relative terms for large scale compost and digestate production, but may make up to 10 % of total costs in the case of very small-scale production. This may be compensated, at least partly, by increased revenues through higher prices in compost and digestate sale, if users accept that there is a sufficiently high benefit to them in terms of avoided compliance costs and better and more reliable product quality.

5.3 Market impact

The main direct impact to be expected from end-of-waste criteria is a strengthened market demand for compost and digestate through:

- Export facilitation for compost/digestate
- Product quality evolution by improved perception by potential users
- Avoidance of compliance costs for compost/digestate use.
- Investment decisions for new biodegradable waste treatment plants

Facilitated exports are especially relevant in areas where the compost or digestate market is saturated because of use restrictions due to strong supply of competing materials for soil spreading, especially manure. According to ORBIT/ECN (2008), shortage in national demand because of competition of other cheap organic material (mainly manure) was the main reason for compost exports in the cases of Belgium and the Netherlands. The Netherlands, for instance, combine a very high population density, one of the highest separate collection rates of

([48]) 1 March 2008 exchange rate.

kitchen and garden waste (ca 190 kg/inhabitant/y), a very large excess of animal manure on the one hand and a very restrictive nutrient/fertilising legislation on the other. Even if theoretically there could still be enough market potential for compost in the Netherlands, prices achieved for compost are low, often even negative, and the Dutch composting industry has already exported considerable amounts of compost under current framework conditions. On average 4.5 % of the annual compost production in Belgium and the Netherlands was exported in 2005 and 2006. Today, however, there is a shortage again of compost in the Netherlands, as fierce competition with manure is no longer an issue, according to the Dutch Environmental Ministry.

Dutch exports to Germany required the participation of Dutch composting plants in the German compost quality certification scheme and bilateral agreement with German *Länder* governments. Currently, Belgian exports to France need to demonstrate both compliance with the Belgian VLACO standard and the French NFU 44051 standard (analysis and certification by French laboratories). It is expected that export possibilities could more easily be developed with European end-of-waste criteria.

The strengthening of domestic compost markets is especially relevant in countries where composting and digestion is only incipient at the moment. By setting EU-wide quality standards for compost and digestate that ensure good and reliable product quality of compliant compost and digestate, end-of-waste criteria, together with accompanying measures to define the conditions for compost and digestate use, may give a boost to compost and digestate markets in these countries.

Avoiding compliance costs for compost and digestate use if waste regulatory controls are not required, is also a factor that favours the compost and digestate market demand. This has been an advantage, for instance, considered in the development of the compost quality protocol in the United Kingdom.

For compost and digestate materials that do not meet end-of-waste criteria it will be increasingly difficult to find market outlets, because their use will require waste regulatory compliance and they will be clearly differentiated as of lower quality. Distinction can be made between two different situations in this case:
a) The compost or digestate material is likely to be upgradable to receive end of waste status.
In some cases, efforts to improve quality management and product quality may be needed in order to succeed in meeting the requirement. The key factor will often be to obtain purer input materials, which will often require measures to introduce, expand or improve the effectiveness of source segregation of biological wastes. Other issues may be linked to process conditions that might need to be changed to meet the hygienisation requirements. Necessary additional investments to reach the end of waste status may be recovered by the producer through higher revenue from the end of waste materials, compared to continue producing waste materials.

b) The compost or digestate material is not likely to be upgradable to receive end of waste
In other cases, it might be more difficult or even impossible to obtain end of waste status for compost or digestate materials without a thorough revision of the process scheme. This may be due to the fact that a certain input material, currently used in large quantities, is banned from the positive list (e.g. sewage sludge). In other cases, the whole process may be set up around a certain input material that is no longer allowed (e.g. mixed municipal solid waste). It can even occur that certain compost or digestate materials that currently enjoy product status in national legislation, may no longer be eligible for product status and receive waste status. In this case,

the economics of composting and digestion will deteriorate (lower, i.e. often negative, compost or digestate prices), compost or digestate production may be abandoned and plants may have to find new outlets for their material, such as landfill or incineration

Finally, setting clear end of waste criteria at EU level, may diminish uncertainties with regard to investment decisions. Available choices will be clearer shaped for decisions on new treatment capacities for biodegradable waste: either production of end-of-waste compliant compost or one of the non-compost or digestate alternatives (including MBT + landfill or incineration). Through strengthening the market demand, while changing the costs of high-quality compost and digestate production only marginally, it can be expected that at more places than today there will be favourable conditions for opting for compost or digestate production. It can also be expected that the establishment of new capacities for the production of non-end-of-waste-compliant compost or digestate will become rather unattractive because of difficulties to find an outlet for the compost or digestate.

5.4 Legislative impact

5.4.1 Impact on national legislation

In some Member States there already exists specific compost or digestate legislation based on waste law, including explicit provisions on the status of compost or digestate as waste or not (e.g. biowaste and compost ordinances in Germany and Austria respectively). It can be foreseen that such legislation would have to be adapted when EU end-of-waste criteria are introduced for compost and digestate.

In other cases there are official rulings or practices by regulatory authorities that link end-of-waste to compliance with certain standards or protocols, like in the United Kingdom. An adaptation to end-of-waste criteria (for example concerning limit values or the need for quality assurance) would also be required in these cases, although these would probably not have to be of a full legislative nature.

As an accompanying measure to end-of-waste criteria, there is a need to adapt existing legislation in Member States regulating the use of compost and digestate to harmonised technical standards on product parameters, sampling and analysis. Furthermore, the use of compost or digestate should be regulated also in those places where no such legislation exists yet.

5.4.2 REACH impact on product status of compost and digestate

One of the most important pieces of legislation with regard to the product status of end of waste compost and digestate is REACH.

REACH is the European Community Regulation on Registration, Evaluation, Authorisation and Restriction of Chemicals (EC 1907/2006)[49]. The law entered into force on 1 June 2007. The aim of REACH is to improve the protection of human health and the environment through the better and earlier identification of the intrinsic properties of chemical substances. The REACH Regulation places greater responsibility on industry to manage the risks from

[49] http://ec.europa.eu/environment/chemicals/reach/reach_intro.htm

chemicals and to provide safety information on the substances. Manufacturers and importers are required to gather information on the properties of their substances, which will allow their safe handling, and to register the information in a central database run by the European Chemicals Agency (ECHA) in Helsinki. One of the main reasons for developing and adopting the REACH Regulation was that a large number of substances have been manufactured and placed on the market in Europe for many years, sometimes in very high amounts, and yet there was insufficient information on the risks that they posed to human health and the environment. REACH was set up to ensure that industry had the information necessary to manage its substances safely.

For compost and digestate falling under the waste regime, REACH is not applicable, as it is stated in Article 2(2) of EC 1907/2006 that "Waste as defined in Directive 2006/12/EC[50] of the European Parliament and of the Council is not a substance, preparation or article within the meaning of Article 3 of this Regulation."

However, compost and digestate no longer holding waste status under end of waste, is to be regarded as a substance and therefore falls under the scope of the REACH Regulation.

Article 2(7)(b) of the Regulation (EC) No 1907/2006 (REACH) and its amendment by Regulation (EC) No 987/2008 of 8 October 2008 sets out criteria for *exempting* substances covered by Annex V from the registration and evaluation requirements as well as certain downstream user obligations as described in Title V, because registration is deemed inappropriate or unnecessary and their exemption does not prejudice the objectives of REACH. Substances included in Annex V are exempted from registration (as well as downstream user requirements and evaluation) for all their possible uses irrespective of the tonnage at which they are manufactured or imported (currently or in the future). It should be noted that the companies benefiting from an exemption must provide the authorities (on request) with appropriate information to show that their substances qualify for the exemption.

Basically, two major exemption cases in Annex V are relevant with regard to compost and digestate, and have been clarified in the "Guidance for Annex V - Exemptions from the obligation to register"[51].

Compost (Entry 12 in Annex V)
This exemption covers compost when it is potentially subject to registration, i.e. when it is no longer waste according to Directive 2008/98/EC (WFD), and is understood as being applicable to substances consisting of solid particulate material that has been sanitised and stabilised through the action of micro-organisms and that result from the composting treatment.
It should be noted that a similar clear exemption is mentioned for biogas, but *not* for digestate as such.

Naturally occurring substances, if they are not chemically modified (Entries 7 & 8 in Annex V)
This group of substances is characterised via the definitions given in Articles 3(39) and 3(40):
According to Article 3(39), ‘substances which occur in nature’ means ‘a naturally occurring substance as such, unprocessed or processed only by manual, mechanical or gravitational

[50] Replaced by Directive 2008/98/EC (WFD)
[51] http://guidance.echa.europa.eu/docs/guidance_document/annex_v_en.pdf

means, by dissolution in water, by flotation, by extraction with water, by steam distillation or by heating solely to remove water, or which is extracted from air by any means’.

Furthermore the guidance document (Guidance on Annex V) states:
It should be noted that whole living or unprocessed dead organisms (e.g. yeast (…), freeze-dried bacteria) or parts thereof (e.g. body parts, blood, branches, leaves, flowers etc.) are not considered as substances, mixtures or articles in the sense of REACH and are therefore outside of the scope of REACH. The latter would also be the case if these have undergone digestion or decomposition resulting in waste as defined in Directive 2008/98/EC, even if, under certain circumstances, these might be seen as non-waste recovered materials.

This would imply that digestate derived from *unprocessed* biological materials (e.g. fruit waste) would be outside the scope of REACH, whereas digestate derived from *processed* biological materials (e.g. residues from jam production) falls under the scope of the REACH regulation.

In conclusion, it follows that:

- compost would be exempt from the REACH registration obligations when it has not reached end of waste status but also when it has as it is included in Annex V
- digestate would be exempt from the REACH Regulation so long as it is still waste, exempt from REACH registration obligations when containing non chemically modified biological materials because of entries 7 and 8 of Annex V, but subject to REACH when containing chemically modified biological materials as it would no longer be waste and could not benefit from the exemptions in entries 7 and 8 of Annex V

As such, under the current circumstances, digestate producers will have to comply with REACH under certain conditions when the end of waste digestate contains chemically modified input materials.

5.4.3 Classification, Labelling and Packaging Regulation

The Classification, Labelling and Packaging Regulation (EC) No 1272/2008 on substances and mixtures (CLP) introduces the Globally Harmonised System of the United Nations (GHS) for the classification and labelling of chemicals (GHS) into all EU Member States. It contributes to the GHS aim that the same hazards will be described and labelled in the same way worldwide. Waste is not considered to be a substance, article or mixture under the CLP Regulation. As long as residues from waste treatment operations are waste, i.e. they are disposed of (e.g. land-filled), they do not fall under the scope of CLP. However, residues which are recovered as substances or mixtures do fall under the scope of CLP. Categories of substances or individual substances listed in the Annex V of the REACH Regulation which are exempted under REACH obligations for registration, evaluation and downstream user provisions, must be notified to the Classification and Labelling inventory only when exhibiting hazardous properties. However, as long as a manufacturer or importer concludes that it is inappropriate to classify a specific substance covered by the Annex V of the REACH Regulation, this substance shall not need to be notified to the Classification and Labelling Inventory.

It can be reasonably concluded that compost fulfilling EoW criteria (e.g. will not lead to overall adverse environmental or human health impacts) would most likely not exhibit any hazardous properties, and thus has not to be labeled according to CLP since it is not classified as hazardous according to CLP. For EoW digestate exempt from REACH obligations for registration according to the stipulations in Annex V, the same reasoning on the hazardous properties would be valid and it would hence be excluded from the CLP obligations as well. However, it appears that EoW digestate subject to REACH might be subject to the obligations of the CLP.

5.4.4 Legal liability and law enforcement

One of the points deserving particular interest is that Member States may have to adjust their control mechanisms when compost or digestate shifts from a waste status to a product status.

It implies that waste regulatory controls will cease to be imposed and that product regulatory controls need to be established.

Furthermore, market surveillance mechanisms should be applied with the aim to detect any fraudulent 'end of waste' products in the market.

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7 Glossary and acronyms

AD: anaerobic digestion

ABPR: **Animal By-Products Regulation**: Regulation (EC) No 1069/2009 of the European Parliament and of the Council of 21 October 2009 laying down health rules as regards animal by-products and derived products not intended for human consumption and repealing Regulation (EC) No 1774/2002 (OJ L 300, 14.11.2009, p. 1-33).

Biodegradable waste: defined in the Landfill Directive as any waste that is capable of undergoing anaerobic or aerobic decomposition, such as food and garden waste, and paper and paperboard

Bio-waste: means biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises and comparable waste from food processing plants. It does not include forestry or agricultural residues, manure, sewage sludge, or other biodegradable waste (natural textiles, paper or processed wood).

CLP: Classification, Labelling and Packaging Regulation (EC) No 1272/2008

Collection: (Follows the definition of the Waste Framework Directive (2008/98/EC)): the gathering of waste, including the preliminary sorting and preliminary storage of waste for the purposes of transport to a waste treatment facility.

Compost: compost is the solid particulate material that is the result of composting and which has been sanitised and stabilised.

Consignment: means a batch of compost/digestate for which delivery from a producer to another holder has been agreed; one consignment might be contained in several transport units, such as containers.

Digestate: digestate is the semisolid or liquid product of anaerobic digestion of biodegradable materials.

Disposal: (Follows the definition of the Waste Framework Directive (2008/98/EC)): any operation which is not recovery even where the operation has as a secondary consequence the reclamation of substances or energy. Annex I of the Directive sets out a non-exhaustive list of disposal operations.

EoW: end-of-waste

Holder: means the natural or legal person who is in possession of compost/digestate.

Importer: means any natural or legal person established within the Union who introduces compost/digestate which has ceased to be waste into the customs territory of the Union.

MBT: **Mechanical Biological Treatment**: means a two step treatment of mixed municipal solid waste consisting of a mechanical separation and sorting step followed by a biological treatment step. Depending on the final goal of MBT, the biological step is either aimed at delivering a landfillable fraction with a minimum of unstable organic material or at producing a stabilized organic compost fraction with a minimum of impurities.

MSW: Municipal solid waste. Means non-sorted, mixed waste from households and commerce, collected together. This waste flow excludes the flows of recyclables collected and kept separately, be it one-material flows or multi-material (comingled) flows.

Mt: Million tonnes. 1 tonne = 1000 kg (International System of Units)

Qualified staff: means staff which is qualified by experience or training to monitor and assess the properties of compost/digestate and its input materials

Recovery: (Follows the definition of the Waste Framework Directive (2008/98/EC)): any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy. Annex II of the Directive sets out a non-exhaustive list of recovery operations.

Recycling: (Follows the definition of the Waste Framework Directive (2008/98/EC)): any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations.

Separate collection: (Follows the definition of the Waste Framework Directive (2008/98/EC)): the collection where a waste stream is kept separately by type and nature so as to facilitate a specific treatment.

Treatment: (Follows the definition of the Waste Framework Directive (2008/98/EC)): recovery or disposal operations, including preparation prior to recovery or disposal.

Visual inspection: means inspection of consignments using either or all human senses such as vision, touch and smell and any non-specialised equipment. Visual inspection shall be carried out in such a way that all representative parts of a consignment are covered. This may often best be achieved in the delivery area during loading or unloading and before packing. It may involve manual manipulations such as the opening of containers, other sensorial controls (feel, smell) or the use of appropriate portable sensors.

WFD: Waste Framework Directive (DIRECTIVE 2008/98/EC OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 19 November 2008 on waste and repealing certain Directives).

8 Annexes

Annex 0: Stakeholder survey December 2010

Ref. Ares(2010)912711 - 07/12/2010

EUROPEAN COMMISSION
DIRECTORATE-GENERAL JRC
JOINT RESEARCH CENTRE
Institute for Prospective Technological Studies (Seville)
Sustainable Production and Consumption Unit

Seville, 7 December 2010
jrc.ddg.j.6(2010)

START OF THE ACTIVITIES OF THE TECHNICAL WORKING GROUP FOR SUPPORTING THE DEVELOPMENT OF END-OF-WASTE CRITERIA FOR BIODEGRADABLE WASTE

Dear Technical Working Group Members,

I have the pleasure in welcoming you as members of the Technical Working Group (TWG) for the development of technical proposals on end-of-waste criteria for Biodegradable waste subject to biological treatment.

The purpose of the TWG is to support the European Commission in preparing measures with specific criteria under Article 6 of the Waste Framework Directive (WFD - 2008/98/EC). The work of the TWG will be managed by the JRC-IPTS. As a result of this work the JRC-IPTS will produce a study with a comprehensive assessment and with technical proposals aimed at defining end-of-waste criteria if such criteria prove feasible in accordance with the conditions laid out in Article 6 of the WFD. The European Commission may propose, on the basis of this study, measures under the regulatory procedure referred to in Articles 6(2) and 39(2) of the WFD ('comitology').

The IPTS will use as a starting base for the new End of Waste criteria an earlier IPTS pilot study on Compost in 2007-2008. The relevant information from this pilot study can be found in Chapter 2 of the report "End-of-waste criteria, methodology and case studies" (see http://susproc.jrc.ec.europa.eu/activities/waste/documents/Endofwastecriteriafinal.pdf).

Call for contributions

Experts from Member States, relevant industry and other stakeholders, in particular those who contributed to the 2007-2008 case study on compost, are kindly requested to review the published information from the case study and asses the need of update and/or additional input, by answering to the questions below. The answers will help the IPTS use the latest available information in the preparation of EoW criteria for Biodegradable waste in 2010-2011.

In order to have the data incorporated in the background document for the first workshop, stakeholders are requested to send back their answers by e-mail (jrc-ipts-end-of-waste@ec.europa.eu) by **09 January 2011**.

1. Do you have any specific remarks regarding the End of Waste (EoW) pilot study report (incorrect or obsolete information, changed viewpoints or regulations, etc.)? Please clearly indicate the page and section you are referring to, based on the above cited document version.

2. Please provide updated data for Chapter 2, Table 1 in the document, i.e. the amount of compost produced in tonnes/year, to be split in biowaste compost, green waste compost,

Edificio Expo. C/ Inca Garcilaso, 3. E-41092 Sevilla
Tel: direct line +34 95 448 8218, switchboard: +34 95 448 8318 Fax: +34 95 448 8235
E-mail: luis.delgado@ec.europa.eu http://ipts.jrc.ec.europa.eu/

sewage sludge compost and mixed waste compost. Please use reference year 2008 for the newly provided data.

3. What are the production data and current uses/markets for other biodegradable waste outputs than compost? Please provide 2008 figures for following streams: non-composted digestate, raw sewage sludge and others (please specify). Please also provide valuable additional market data such as resale prices, costs, gate fees, etc.

4. Do you see any benefits and/or disadvantages in expanding EoW criteria to other biodegradable waste treatment products than compost, such as non-composted digestate or sewage sludge? If you see benefits, how do you think that EoW criteria should be adjusted?

5. Has your country made any provisions for EoW criteria or quality criteria for other biodegradable waste than compost, such as non-composted digestate or sewage sludge? Please specify.

6. What would be the influence of setting EoW criteria for compost or other biodegradable waste streams at EU level on your country's national legislation?

7. Please provide statistical data on the quality of different types of composts according to your country's classification, as well as other biodegradable waste treatment products such as non-composted digestate or sewage sludge. These can include mean values, standard variations and percentiles of organic matter, heavy metals, organic pollutants, impurities, etc.

Next steps

The JRC-IPTS will compile and analyse all contributions submitted by the TWG and will organise a first workshop on 2 March 2011, at the IPTS (Seville). This workshop will allow discussion on topics described in the background paper. The official invitation including the program of the workshop will be sent at the beginning of February 2011. In order to have a balanced distribution of stakeholders, we would like all member states and organizations to propose one delegate to represent them at the workshop. Furthermore, due to infrastructure restrictions, the number of workshop participants is limited. Hence, we would advice not to arrange any travel before reception of the official invitation to the workshop.

A draft study report will be prepared by the JRC-IPTS after the workshop. It will be based on the inputs and comments from the expert group, including the written inputs and the discussions at the workshop, and be submitted again to the members of the expert group for comments and possibly requesting additional inputs.

Please send your contributions to the following email address:

jrc-ipts-end-of-waste@ec.europa.eu

Should you have any questions regarding this letter or related to end-of-waste criteria for Biodegradable waste, please do not hesitate to contact Hans Saveyn by e-mail **Hans.Saveyn@ec.europa.eu** or by phone +34 954 488 470.

Yours sincerely,

Luis Delgado Sancho
Head of Unit

Annex 1: Overview of the management of biodegradable waste in EU Member States. Based on ORBIT/ECN (2008) and stakeholder survey December 2010.

Legend:

Bio and green waste composting	Anaerobic digestion	Mixed municipal solid waste composting	Mechan. biological treatment	Landfilling	Incineration
B/GWC	AD	MSWC	MBT	LAND	INCIN

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
AT	x	x	-	x	-	x

Biological waste treatment

Country wide statutory separate collection of bio- and green waste and the necessary composting capacity exist.

Landfilling and mechanical biological treatment

Austria has realised a national ban on landfilling of untreated and biodegradable waste in 2004 and meets the targets of the EU landfill directive. MBT plants with 0.5 million tons of treatment capacity stabilise the organic part of the residual MSW (after separate collection of bio-waste) so it meets the Austrian acceptance and storage criteria for landfills.

Incineration

Incineration is well established in Austria but besides sewage sludge not for organic waste.

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
BE	x	-	-	-	-	x

The Waste Management System in Belgium is assigned to the 3 regions. Each region has its own waste management legislation and policy. No information from the Brussels region is available.

Biological waste treatment

Separate collection of bio- and green waste and the necessary composting capacity exist in Flanders supplemented by a waste prevention programme which reduces the waste amount for landfilling and incineration.

Landfilling and mechanical biological treatment

Landfilling of waste is intended to be reduced to the maximum level by waste prevention, recycling and mechanical biological treatment in Flanders. Only waste which can't be recycled or incinerated should be landfilled. Flanders meets already the reduction targets of the landfill directive after a ban on landfilling of organic waste in 2005.

Incineration

Incineration is well established in Flanders and Wallonia.

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
CY	-	-	-	-	x	-

Biological waste treatment

In order to meet the EU diversion targets biological waste treatment capacities have to be built.

Landfilling

The full implementation of the landfill directive is planned for the year 2009. It requires a number of up to 100 existing landfill sites to be closed and replaced by 4 non-hazardous waste treatment and disposal centres plus 1 hazardous waste treatment centre. It also requires the establishment of a separate collection system for recyclable (packaging) waste and the promotion of composting of biodegradable waste.

Incineration

No essential capacities recorded

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
CZ	x	-	-	-	x	x

Biological waste treatment

The National Waste Management Plan 2002 -2013 in the Czech Republic includes challenging targets for separate collection and composting of biowaste in its Implementation Programme for biodegradable waste.

Landfilling

An implementation plan of the Landfill Directive has been prepared already in the year 2000 to meet all the nine key requirements of the EU landfill directive.

Incineration

Incineration capacity is part of the Czech waste management.

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
DE	**x**	**x**	**-**	**x**	**-**	**x**

Biological waste treatment
Country wide separate collection of bio- and green waste and the necessary composting and anaerobic digestion capacity of around 12 million t annually exist.
Landfilling and mechanical biological treatment
Germany has realised a national ban on landfilling of untreated and biodegradable waste by June 2007 and surpassed the targets of the EU landfill directive already. Around 50 MBT plants with 5.5 million tons of treatment capacity stabilise the organic part of the residual MSW (after separate collection of bio-waste) so it meets the German acceptance and storage criteria for landfills.
Incineration
Incineration is well established in Germany but, except for sewage sludge, not for organic waste. Additional capacity is under construction especially designed for the high calorific fraction from MBT.

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
DK	**x** GWC	**-**	**-**	**-**	**-**	**x**

Biological waste treatment
Collection and composting of green waste is well developed and diffused in Denmark. Bio-waste composting stays more or less on a pilot scale.
Landfilling
The number of landfill facilities in Denmark is expected to be reduced further. The requirements laid down in the Statutory Order on Landfill Facilities are expected to lead to the closure of 40-60 landfill facilities (out of the approx. 150 existing facilities) before 2009.
Incineration
Denmark largely relies on waste incineration. The general strategy is a ban on landfilling of waste that can be incinerated (is suitable for incineration).

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
EE	**x**	**-**	**-**	**-**	**-**	**-**

Biological waste treatment
The Estonian National Waste Plan suggests the collecting garden waste in cities and enhancing home composting in rural areas.
Landfilling
For biodegradable municipal waste, the Estonian National Waste Plan gives a general priority to separate bio-waste from mixed MSW before landfilling. The plan proposes to increase bio-waste recovery from 20.000 t in 2000 to 290.000 to 350.000 t in the year 2020 and to decrease landfilling of biodegradable waste from 390.000 to 450.000 t in 2000 to 40.000 t in 2020. This shift of capacities requires essential alternative treatment by composting or mechanical biological treatment.
Incineration
No essential capacities recorded.

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
ES	**x**	**x**	**x**	**-**	**x**	**x**

Biological waste treatment
The national Waste Management Plan (NWMP 2008-2015) indicates a general target for the separate collection of the organic fraction of MSW to be treated by composting or AD. This should be increased up to 2 million tonnes (from 417.078 tonnes separate collected in 2006).
Landfilling
Biodegradable waste going to landfills should be reduced from 7.768.229 tonnes in 2006 (68% of MSW) to 4.176.950 in 2016 in order to fullfill the targets established in the Landfill Directive.
Incineration
The plan foresees to increase the incineration capacity with energy recovery from 2,1 million tonnes in 2006 to 2,7 million tonnes in 2012. A 9% of the total MSW collected in 2006 were incinerated.

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
FI	**x**	**x**	**-**	**x**	**x**	**-**

Biological waste treatment
A most important policy document in relation to biodegradable waste management is the National Strategy on Reduction of Disposal of Biodegradable Waste on landfills according to the EU landfill directive requirements. This strategy also provides means and assistance in order to reach the objectives set out in the landfill directive. Scenarios of the strategy give statistics and forecasts for biodegradable waste production and treatment for the years 1994, 2000, 2006 and 2012.
The strategy contains an assessment of present biodegradable waste quantities and a forecast and various technological (incl. composting, digestion, mechanical biological treatment) and infrastructural scenarios including waste prevention.
Landfilling
The Finish waste management strategy in the past was already quite effective in reduction efficiency for biodegradable waste on landfills with less than 50 % of the volume than 10 years before.

Incineration
No essential capacities recorded.

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
FR	**x**	**-**	**x**	**-**	**x**	**x**

Biological waste treatment and mechanical biological treatment MBT
Composting of selected biodegradable MSW is increasing but is still not consolidated (141,000 t in 2002). MSW mixed bio-composting (called raw waste composting) is expected to increase essentially due to advanced technology screening and new lower national thresholds for the compost quality.
In the last years the collection of green waste has strongly progressed through the setting up of collection points. Also, the French agency ADEME has supported numerous composting projects.
The biological pre-treatment of waste is not widespread in France, but the experiences of the existing sites are followed with interest.
Landfilling
Today waste landfilling still represents the most applied management options for MSW in France: 42% of MSW are sent to landfills in 2002. From 2009 all landfills shall comply with the EU landfill directive requirements and diversion requirements.
France already largely respects the targets of 2006 and 2009 set by EU Directive on landfills. However, the estimated amount of biodegradable municipal waste going to landfill in 2016 is 40% of the total amount produced in 1995 but 35% is required by the EU Landfill directive for 2016. In accordance with this requirement the waste management plans have been revised with a stronger orientation towards recycling.
Incineration
There are approximately 130 incinerators at present in France. Some waste management plans foresee the construction of new incineration plants, some of which are already under construction. It is estimated that the amount of waste going to incineration will increase by 1- 2% in the next years. The capacity allows the biodegradable waste can be incinerated to a certain extent.

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
GR	**-**	**-**	**-**	**x**	**x**	**-**

Biodegradable waste treatment
Legislation JMD 50910 repeats the dual commitment of the Greek government to close down all illegal landfills by the end of 2008 and to reduce the biodegradable municipal waste to 65% by 2020. Intermediate targets are: 25% (2010) and 50% (2013). The targets will be achieved through the operation of recycling and composting facilities in almost all regions of the country as well as through the full operation of the separate collection systems for selected waste streams.
At the moment, there are no facilities processing source separated organic waste, although it would be fairly easy to do so with at least the green wastes, as they are collected separately anyway and some municipalities have thought of doing so.
Mechanical biological treatment MBT
Various regional waste management plans foresee the construction of MBT plants as the main tool to meet the Landfill Directive targets. At present 3 such plants are in operation. Obviously, while the option to revise the waste management plans to include other options such as thermal treatment or source separation is always open, but conditions for any of these options do not seem to be mature yet.
Landfilling
Until the early 1990s, the use of uncontrolled dumps was the "traditional" method of solid waste disposal. Since then, the overall situation has dramatically improved: There are 45 sanitary landfills constructed in Greece (41 already operational) whereas 47 more sites are under construction including the expansion of existing ones. Last data for the year 2003 reports that 1032 dumping sites, mainly small, were still operating in various municipalities of the country. It is expected that by the end of 2008, uncontrolled waste dumping will cease to exist.
Incineration is not well diffused in Greece

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
HU	**x**	**-**	**-**	**x**	**x**	**-**

The National Waste Management Plan (NWMP) valid from 2003 till 2008 prescribes the general tasks of waste management in Hungary. Main goals and targets:
Biological waste treatment
50% reduction of landfilled quantity of biodegradable waste of the volume generated in 1995 till 2007 The National Bio-waste Programme (BIO-P, 2005-2008) has the following preferences to reduce BMW: recycling (paper), composting, anaerobic digestion (biogas generation), MBT, thermal utilisation.
The needed capacity building until 2008 is 460.000 t/y composting and 100.000 t/y MBT (HU[52])
Landfilling
Revision and liquidation of the old landfill sites till 2009. At the end of 2008 approximately half of all waste not including biomass must be recovered or used in power engineering
Incineration

[52] STRATEGIC EVALUATION ON ENVIRONMENT AND RISK PREVENTION UNDER STRUCTURAL AND COHESION FUNDS FOR THE PERIOD 2007-2013 - Contract No. 2005.CE.16.0.AT.016. "**National Evaluation Report for Hungary - Main Report"** Directorate General Regional Policy. A report submitted by GHK Brussels, Nov. 2006, p. 217. http://ec.europa.eu/regional_policy/sources/docgener/evaluation/pdf/strategic_environ.pdf (download 15 Oct. 2007)

The old waste incinerators will be renovated or closed till 2005 (accomplished).

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
IE	**x**	**x**	**-**	**x**	**x**	**-**

The Irish waste management policy includes a strategy for a dramatic reduction in reliance on landfilling, in favour of an integrated waste management approach which utilises a range of waste treatment options to deliver effective and efficient waste services and ambitious recycling and recovery targets. Alternative waste treatment options like composting, digestion, MBT or incineration more or less doesn't exist.

National Strategy on Biodegradable Waste (2004) sets the following targets for 2013:

- Diversion of 50% of overall household waste away from landfill
- A minimum 65% reduction in Biodegradable Municipal Waste (BMW) sent to landfill
- Developing biological treatment capacity (composting, MBT or AD) of up to 300,000 t/y
- Recycling of 35% of municipal waste
- Rationalisation of municipal waste landfills to a network of 20 state-of-the art sites
- Reduction of methane emissions from landfill by 80%

Composting and digestion are undertaken in Ireland. The mechanical treatment of mixed municipal waste is increasing but the biological treatment of the mixed municipal fines produced is still at low levels.

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
IT	**x**	-	-	**x**	-	**x**

Integrated biodegradable waste management with composting, MBT and incineration

Italy has established waste management in an integrated way according to the specific properties of the different material flows using separate collection and recycling and the treatment options incineration (incl. energy recovery), mechanical biological treatment (12 million t annual capacity - to segregate the high calorific faction and to stabilise the organic part before landfill) and composting of source separated bio- and green waste (2.8 million t/y).

Landfilling and biological mechanical treatment MBT

In Italy the implementation of the Landfill Directive includes strict limits as regards organic matter (TOC) and the calorific value of the waste to be landfilled. So pre-treatment of the waste by means mechanical biological treatment to allow to stabilisation or energy recovery is necessary.

Coherently with decree 36/03 the Regions shall plan a strategy in order to decrease the amount of biodegradable waste going to landfills. Before 27 March 2008 biodegradable municipal waste must be reduced to less than 173 kg per inhabitant per year, before 27 March 2011 to less than 115 kg and before 27 March 2018 to be reduced to less than 81 kg per inhabitant per year

The waste management strategy identifies the following instruments to be implemented in order to achieve the targets:

- economic instruments to discourage landfill disposal
- separate collection of organic, wooden and textiles fractions
- mechanical/biological treatment
- biological treatment
- incineration with energy recovery
- ban on landfilling of certain waste streams

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
LT	**x**	**x**	**-**	**x**	**x**	**-**

Biological waste treatment

The development of the overall waste management system in Lithuania from 2006 aimes at meeting the targets of diverting biodegradable waste from landfills set in the landfill directive. It is assumed that set targets will be met by increasing the efficiency of separate collection of biodegradable waste and recyclables and implementation of facilities for treatment and recovery of biodegradable waste, i.e. composting.

In regional waste management projects currently under implementation, construction of green waste composting facilities is foreseen in most of the municipalities. However, in order to meet the stringent requirements of the Landfill Directive it is also envisaged that in future some form of additional waste treatment will be required, i.e. incineration (with energy recovery), mechanical-biological treatment, anaerobic digestion, etc.

In Lithuania many waste management companies have started composting activities due to a ban on the disposal in landfills of biodegradable waste from gardens, parks and greeneries,.

Landfilling

The lack of environmentally safe waste disposal sites is a key problem of waste management in Lithuania. Special efforts have to be invested into the development of new landfills which meet all environmental requirements included in EC Directive 1999/31/EC. Lithuania has indicated that no landfilling will take place in non-complying landfills after 16 July, 2009.

Incineration

There are no waste incinerators in Lithuania designed specifically for the combustion of waste.

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
LU	**x**	**x**	**-**	**-**	**x**	**-**

National and local Waste Management Plans from 2005 includes the following quantitative objectives (% by weight) should be attained for domestic waste, bulky waste and similar wastes (reference year: 1999):

• organic wastes: rate of recycling of 75 %

• rate of recycling of 45 %
• other recoverable wastes: rate of recycling of 45 %

No further detailed information on landfilling and incineration is available.

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
LV	**x**	**-**	**-**	**-**	**x**	**x**

Biological waste treatment
No biological treatment besides pilot projects
Landfilling
Latvia relies on landfilling
Incineration
No incineration capacity for MSW.

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
MT	**-**	**-**	**-**	**-**	**x**	**-**

Biological waste treatment
No biological treatment, only one pilot project on composting. Activities for separate collection and composting were intended for 2006 with no real progress until now.
Landfilling
Malta relies on landfilling
Incineration
No incineration capacity for MSW.

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
NL	**x**	**-**	**-**	**-**	**-**	**x**

The Ministry of Environment has issued a National Waste Management Plan for the period 2009-2021 with the essential provision to promote waste recovery, particularly by encouraging waste separation at source and subsequent separation of waste streams. Waste separation allows for product reuse, material reuse and use as fuel. The level of waste recovery must accordingly increase from 83% in 2006 to 85% in 2015.
Biological waste treatment
The Netherlands show with 3.3 million tons/year the highest recovery rate for source separated bio- and green waste in Europe.
Landfilling
Landfilling of the surplus combustible waste, as currently happens, must be finished within five years. The Waste (Landfill Ban) Decree came into force in 1995 and prohibits landfilling of waste if there is a possibility for reusing, recycling or incinerating the waste.
Incineration
Incineration should optimise use of the energy content of waste that cannot be reused by high energy efficiency waste incineration plants.

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
PL	**x**	**-**	**x**	**x**	**x**	**-**

Biological waste treatment
Biological waste should be collected separately by a 2 bins system mainly in the cities. Before July 2013 not less than 1.7 million tons/year, before 2020 not less than 2.2 million tons capacity should be installed which means the construction of 50 composting plants between 10.000 t and 50.000 t capacity.
In practice today there is only mixed waste composting with low qualities mainly used as landfill cover.
Referring to garden waste n the National Waste Management Programme it is implied that 35% of this waste category will undergo the process of composting in 2006, and 50% in 2010.
Landfilling
Poland has been granted a transition until 2012 for the implementation of the Landfill Directive. According to the Treaty of Accession, intermediate targets until 2012 were set out for each year, how much waste may be deposited in landfills.
Incineration
No essential capacities recorded

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
PT	**x**	**x**	**x**	**x**	**x**	**x**

Biological waste treatment
In order to reduce biological waste going to landfills the 2003 National Portuguese Strategy promotes separate collection and composting or anaerobic digestion. An increased capacity from 285.000 t for organic waste in 2005 up to 861.000 t in 2016 should be constructed with 10 large and several small organic waste treatment plants.
Landfilling
In 2003 the National Strategy for the reduction of biodegradable urban waste from landfills came into force in order to meet the EU Landfill Directive requirements. Additional recycling and incineration capacities should help to fulfil the diversion targets. Lately, mechanical biological treatment is prioritised instead of recycling via composting or digestion of separately collected organic waste.

Incineration
A third incineration plant and extension of the existing incinerators is intended.

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
SE	**x**	**x**	**-**	**-**	**-**	**x**

Biological waste treatment

- • 2010 at least 50% of household waste is recycled, incl. biological treatment
- • 2010 at least 35% of food waste from households, restaurants, institutions and shops is recycled through separate collection and biological treatment.
- • 2010 food waste from food industry is recycled through biological treatment.
- Biological treatment will be mainly - besides green waste composting - based on anaerobic digestion.

Landfilling
Ban on combustible waste 1 January 2002 and on compostable waste: 1 January 2005
Inadequate statistics on how much combustible and organic waste is landfilled make it difficult to assess the need for increased capacity to comply with the prohibitions.
No essential activities on mechanical biological treatment MBT
Waste incineration is well accepted and diffused

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
SI	**x**	**x**	**-**	**-**	**x**	**-**

Biological waste treatment
The management of biodegradable waste is determined by various legislation documents. The Decree on the landfill of waste lays down the permitted quantities of biodegradable components in municipal waste that may be landfilled in Slovenia.
In order to reduce the quantities of biodegradable waste, concurrent with introducing limits on volume of biodegradable waste, three additional regulations have been adopted, Decree on the management of organic kitchen waste and garden waste, Decree on the treatment of biodegradable waste and Decree on the management of waste edible oils and fats. The Decree on the treatment of biodegradable waste introduced compulsory operations considering the treatment of biodegradable waste and conditions for use, as well as in regard to placing treated biodegradable waste on the market.
From the aspect of protecting natural resources, increasing the proportion of recycled and recovered waste as well as reducing the negative environmental impact from landfilling, Slovenia adopted in 2008 an Operational programme on elimination of wastes with objective to reduce the quantities of biodegradable waste disposal. Its main aim is to reduce quantities of biodegradable waste as well as establishment of a complete network of facilities and plants for waste management. In line with population number and geographical distribution, the plan was developed for 13-15 waste management centres. The general concept of waste management envisages activities on three levels – local, regional and supra-regional. In the beginning of 2011 the revision of the Operational program is expected.

Landfilling
Today waste landfilling still represents the most applied management option for MSW in Slovenia.
According to the Statistical Office of the Republic of Slovenia, 822.700 t of waste were deposited on landfills in 2008. The average structure of waste deposited on public infrastructure landfills in 2008 was as follows: 79.2% municipal waste, 9.4% construction waste, 3.8% sludge from waste water treatment, 0.1% packaging waste, 0.7% waste from wood and paper processing and 6.7% other types waste.
See also data :ARSO | KOS

Incineration
There are no waste incinerators in Slovenia designed specially for the combustion of municipal solid waste.

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
SK	**x**	**-**	**-**	**-**	**x**	**-**

Waste Act No. 223/2001 Coll. regulates the whole waste management. The waste management plan WMP SR for 2006-2010 was approved by the Government in 2006. Municipalities prepare waste management plans and are responsible for all waste generated within.
Biological waste treatment
Article 18 (3m) of Act No 223/2001 does not allow to landfill green waste and also entails an obligation of separate collection of biodegradable municipal wastes to municipalities. The WMP defines the target for 2010 as decrease of biodegradable municipal waste landfilling on 20% of 2005. The municipalities are responsible for recovery of green waste. Usually they operate (or co-operate with agricultural farms) composting or biogas plant.
Landfilling and incineration
Targets for 2010 for waste management for non hazardous wastes are the following 70% recovery, 0 % incineration and 19 % landfilling.

The Slovak Report about the needs for the next Cohesion Funds period estimates until 2013 the need of 400 to 900 small municipal compost plants and 6 to 10 large ones. [53]

OPTIONS	B/GWC	AD	MSWC	MBT	LAND	INCIN
UK	**x**	**x**	**-**	**x**	**x**	**-**

Biological waste treatment

The UK Government and the National Assembly have set challenging targets to increase the recycling of municipal waste: To recycle or compost at least 25% of household waste by 2005, at least 30% of household waste by 2010 and at least 33% of household waste by 2015. No further provisions are made to which extent alternative treatments like MBT or AD are part of the strategy.

Green waste composting is well developed and diffused in UK. AD shows growing interest.

Regions in UK have different specific targets recycling and treatment target exceeding the national requirements

Landfilling: Landfilling allowances can be traded within the municipalities by the LATS Landfill Allowance and Trading Scheme.

Incineration:

Incentives exist to shift waste treatment from incineration, which is not very well diffused in UK.

[53] Strategic evaluation on environment and risk prevention under structural and cohesion funds for the period 2007 -2013 - Contract No. 2005.CE.16.0.AT.016. "National Evaluation Report for Slovakia - Main Report" Directorate General Regional Policy. A report submitted by GHK Brussels, Nov. 2006. http://ec.europa.eu/regional_policy/sources/docgener/evaluation/pdf/strategic_environ.pdf (download 15 Oct. 2007)

Annex 2: National approaches and criteria to define whether compost produced from waste may be marketed as product or is still within the waste regime. Source ORBIT/ECN (2008) and stakeholder survey December 2010.

	Compost = PRODUCT or WASTE	**Legal basis or standard**	**Main criteria for** **1) compost ceasing to be waste and/or** **2) placing on the market and use of compost even under the WASTE regime**
AT	**PRODUCT**	Compost Ordinance BGBl. I 291/2001	• Central registration of compost plant • Positive list of input materials • Comprehensive documentation of o Waste reception o Process management and material movement o Compost quality criteria o Product designation, declaration, labelling and selling of compost • External sampling and product certification by acknowledged institute If all criteria are met and approved by the external certification system all types of compost can be marketed as PRODUCT.
BE Flanders	**PRODUCT (secondary raw material)**	VLAREA Flemish Regulation on waste prevention and management (B.S. 1998-04-16)	Total quality control of the VLACO-certificate includes: • Input criteria, • Process parameters, • Standards for end-product • Correct use Compost remains WASTE in any case. User certificate by OVAM is necessary only for the application of sewage sludge compost
BE Wallonia	**WASTE**	Decree on compost and digestates (currently being examined by the Walloon Government)	Compost does not cease to be waste Four classes (A, B, C, D) and two subclasses (B1, B2) are defined in the classification system proposed by the administration for all materials. Composts belong to class B, and are distributed between class B1 and B2 according to the type or origin of the material Material of class D can not be used on or in the soils; Material of class C can not be used on or in agricultural soils; Material of class A of B can be used on or in agricultural soils. i. Norms of subclass B2 are those applied for treatment plant sludge that can be recovered in agriculture in accordance with European legislation, i.e. a management at the field level together with a preliminary soil analysis must be undertaken (field level traceability with soil analysis). In order to protect soils from metallic element traces, a maximum quantity of material spreading is defined and the soil is preliminary analysed for metallic element traces (in order to avoid exceeding a defined level) ii. Norms of subclass B1 are less restrictive than subclass B2 due to the lower concentration in metallic element traces and in organic compound traces of certain material (such as wastes from food-processing industry, green wastes compost, decarbonation sludge, etc), and due to criteria that must be followed within the Water Code on sustainable nitrate management in agriculture. Therefore, preliminary soil analyses are not needed for subclass B1, which simplifies the use

	Compost = PRODUCT or WASTE	Legal basis or standard	Main criteria for 1) compost ceasing to be waste and/or 2) placing on the market and use of compost even under the WASTE regime
			of these materials on or in agricultural soils. The presence of a quality management system allows the traceability to be at the farm/firm level, otherwise the field level traceability is maintained.
BG	---	---	---
CY	---	---	---
CZ	**PRODUCT**	Act on fertilisers 156/1998 Sb. by the Public Ministry of Agriculture ČSN 46 5735 Průmyslové komposty Czech Compost Standard	Fertiliser Registration System; Central Institute for Supervising and Testing in Agriculture, the Czech Environmental Inspectorate One Compost Class; Quality requirements correspond to Class 1 of the Czech Compost Standard but with less quality parameter compared to the waste composts. The use is not restricted to agriculture. Compost has only to be registered for this group and the inspection/control of samples is done by the Control and Test Institute for Agriculture which is the Central Institute for Supervising and Testing in Agriculture.
	PRODUCT	Biowaste Ordinance (In preparation)	All 3 Classes foreseen in the new draft Compost Ordinance are defined as END of WASTE criteria
DE	**WASTE**	Fertiliser Ordinance (26. November 2003) Closed Loop Management and Waste Act (KrW-/AbfG); Biowaste Ordinance (BioAbfV, 1998)	Compost also from source separated organic waste is seen as WASTE due to its waste properties and its potential to pose negative impacts to the environment. (risk of contamination) • Positive list for input materials • Hygienically harmless • Limit value for heavy metals • Requirements for environmentally sound application • Soil investigation • Official control of application by the waste authority • Documented evidence of approved utilisation All classes and types of compost, which are produced from defined source materials under the Biowaste Ordinance remain WASTE
	WASTE-product (!)	RAL Gütesicherung RALGZ 251	When participating in a voluntary QA scheme relaxations are applied with respect to the regular control and approval protocols under the waste regime. Though, legally spoken compost remains WASTE quality assured and labelled compost can be extensively treated and handled like a product. The relaxations are: • No soil investigation • No official control of application by the waste authority • No documented evidence of approved utilisation In principle all classes and types of compost, which are produced from defined source materials under the Biowaste Ordinance remain WASTE, but in practice, if certified under QAS of the RALGZ 251 compost can be marketed and used quasi like a PRODUCT.
DK	**WASTE**	Stat. Order 1650 of 13.12.06 on the use of waste (and sludge) for agriculture	The use of compost based on waste is under strict regulation (maximum of 30 kg P/year/ha etc. and the concentration of heavy metals in the soil were applied must not exceed certain levels. For this reason the authorities want to know exactly where the compost ends up which is only possible if handled as waste and not as a product (for free distribution). Compost from garden waste is not formally regarded as a product but is treated according to the general waste regulation for which the municipalities are responsible.

	Compost = PRODUCT or WASTE	Legal basis or standard	Main criteria for 1) **compost ceasing to be waste and/or** 2) **placing on the market and use of compost even under the WASTE regime**
EE	**WASTE**	Environmental Ministry regulations 2002.30.12 nr. 78 and in Environmental Ministry regulation 2002.01.01 nr. 269.	Heavy metal limits in compost (sludge compost) No specific regulation on compost from biowaste and green waste
ES	**PRODUCT**	Real Decree 824/2005 on Fertilisers Products	• Input list (Annex IV) • Documentation (Art. 16): declaration of raw materials, description of production processes, certification to declare the fullfillment of all legal requirements • Minimum criteria for fertilizer products to be used on agriculture or gardening (Annex I): raw materials, how it shall be obtained, minimum nutrient contents and other requirements, parameters to be included on the label. • Quality criteria for final compost (Annex V): heavy metals content, nitrogen %, water content, Size particle, maximum microorganism content, limitations of use.
FI	**WASTE** **PRODUCT**	Jätelaki (Waste Act) Fertiliser Product Act 539/2006 Decree of the Ministry of Agriculture and Forestry on Fertiliser Products 12/07	WASTE status changes to PRODUCT if compost fulfils the criteria of fertiliser regulation and is spread to land or mixed into substrate. But there is no external approval or inspection scheme. Samples can be taken by compost producer! Waste can be used in fertiliser product, if compost fulfils the criteria of the national fertiliser product legislation. The fertiliser product must be produced in an approved estab-lishment which has self-supervision. The fertilisers products have to full fill the the general require-ments and type designation requirement before marketing
FR	**PRODUCT**	NFU 44051 Standard	Mixed waste compost – no positive list! 4 Product types • "Organic soil improvers - Organic amendments and supports of culture" • "Organic soil improvers - Composts containing substances essential to agriculture, stemming from water treatment (sludge compost)" • "Organic amendments with fertiliser" • "supports of culture" Further following quality criteria: • Limit values for: trace metal concentrations and loads (g/ha*y), impurities, pathogens, organic micro-pollutants • Labelling requirements There is no regular external approval or inspection scheme. Samples can be taken by compost producer. However, there exists a legal inspection by the competent authority based on the IPPC procedure which in FR is also applied to composting facilities. Compost which is not produced according to the standard is WASTE and has to follow a spreading plan and may apply for a temporary product authorisation. By this way the standard can easily be by-passed.
GR	**PRODUCT**	Common Ministerial Decision 114218, 1016/B/17- 11-97. Fertiliser law (Law 2326/27-6-1995, regulating the types of licenses for selling fertilisers).	Compost is considered as product and may be sold, provided it complies with the restrictions of the frame-work of Specifications and General Programs for Solid Waste Management. No sampling protocol and analysis obligations/ organisations are defined. Composts produced from materials of agricultural origin (olive-mill press cake, fruit stones, tree trimmings, manures etc) are considered products and sold under the fertilisers law

	Compost = PRODUCT or WASTE	Legal basis or standard	Main criteria for 1) compost ceasing to be waste and/or 2) placing on the market and use of compost even under the WASTE regime
HU	**PRODUCT**	36/2006 (V.18.) Statutory rule about licensing, storing, marketing and application of fertiliser products	Composts are in waste status as long as they are not licensed under the Statutory rule Nr. 36/2006 (V.18.). After the licensing composts may become a PRODUCT. To achieve the product status needs to be in accordance with the Statutory rule Nr. 36/2006 (V.18.). Criteria: • Input-List, • External quality approval by acknowledged laboratories, • physical, chemical and biological quality parameter for final compost.
IE	**PRODUCT**	EPA Waste license or Local Authority waste permit	Product status is based on site specific waste licence or waste permit; compliance with all operational and product requirements laid down in the consent document must be shown by producer. There is NO legal standard or QAS or quality protocol in Ireland at the moment which will say when waste becomes a product.
IT	**PRODUCT**	L. 748/84 (law on fertilisers); D.M. 05/02/98 (Technical Regulation on simplified authorization procedures for waste recovery)	Criteria for product status are based on National Law on Fertilisers, which comprises: • Qualitative input list (source segregated organic waste • Quality parameters for final compost • Criteria for product labelling Compost from MBT/mixed waste composting plants may still be used under the old Decree DPR 915/82 - DCI 27/7/84 as WASTE for restricted applications (brown fields, landfill reclamation etc).
LT	**PRODUCT**	Decree of the Ministry for Environment (D1-57/Jan 2007)	According to environmental requirements for composting of biowaste the compost producer must provide a certificate on the compost quality • Compost sampling is done by the PRODUCER (!) • NO external approval or plant inspection
LU	**PRODUCT**	Waste licence	The Product Status is achieved only when a QAS is applied. QAS is an obligatory element of the waste licensing of composting plants. The further criteria are: • Positive list for input materials • Hygienically harmless (Process requirements and indicator pathogens) • Limit value for heavy metals • Requirements for environmentally sound application (labelling
LV	**PRODUCT**	Licensing as organic fertiliser (Cabinet Regulation No. 530 " Regulations on identification, quality, conformity and sale of fertilisers" 25.06.2006)	Quality of the compost, its composition. The Product Status is achieved only when it is registered and tested by certificated laboratory. The further criteria are: • Hygienically harmless • Limit value for pollutants
MT	**WASTE**	---	NO provisions for compost
NL	**PRODUCT**	Fertiliser act (2008)	One or more organic components, but no animal manure, broken down by micro-organisms into such a stable end product that the composting process is slowed down considerably. • key criteria o The composting process (hygienisation) and its documentation o stability (no value) and o the absence of animal manure.

	Compost = PRODUCT or WASTE	Legal basis or standard	Main criteria for 1) compost ceasing to be waste and/or 2) placing on the market and use of compost even under the WASTE regime
			o heavy metal limits o minimum organic matter content o declaration & labelling
PL	**WASTE**	Fertiliser law	Ministerial Approval by Min. of Agriculture and Rural Development Criteria: • Limit values for heavy metals (3 classes; also coarse and fine compost) • Test on Pathogens
PT	**PRODUCT**	NP 1048 – Standard for fertilisers Portaria 672002 pg 436	Compost is interpreted as organic soil amendment *"Correctivo organico"* There are no specific regulations available.
RO	---	---	NO provisions for compost
SE	**WASTE**	Private QAS and SPRC 152 (compost standard)	Waste Criteria: definition according to European court of justice. The compost standard is managed by the Swedish Standardisation Institute SP)
SI	**PRODUCT**	Decree on the treatment of biodegradable waste (Official Gazette of the Republic of Slovenia, no. 62/08)	If compost meets the requirements of this Decree, compost is a PRODUCT. If limit values are not met the compost can be used as WASTE. Provided risk assessment is carried out by an accredited laboratory. Criteria: Limit values for heavy metals (3 classes) and AOX, PCBs Maximum levels for glass, plastics, metals But: Compost sampling is done by the producer (!); no QAS certification!
SK	**PRODUCT**	Act No. 223/2001 Col. on waste as amended Slovak technical standard (STS) 46 57 35 Industry composts Act No. 136/2000 Col. on fertilisers Act No. 264/1999 Col. about technical requests for products Regulation of the Government No. 400/1999 Col. which lays down details about technically requirements for products	After biowaste has gone through recovering process it is considered as compost, but such product can not be marketed Compost may be marketed in case it is certified by an authorised person according to Act No. 264/1999 Col. Key criteria for the PRODUCT status: • Quality parameter for final compost – STS 46 57 35 • Process parameter (sanitisation) – STS 46 57 35§ • Quality approval by acknowledged laboratory or quality assurance organisation – Act No. 264/1999 Col.
UK	**WASTE**	Waste Management Licensing Regulations Animal By-Products Regulations	England, Wales, Scotland and Northern Ireland: Compost must be sold/supplied in accordance with the Waste Management Licensing Regulation rules for storing and spreading of compost on land (these rules apply whether or not the compost is derived from any animal by-products). There are not any quality criteria / classes but in the application form and evidence (test results for the waste) sent to the regulator, 'agricultural benefit' or 'ecological improvement' must be justified. The regulator makes an evaluation taking account of the characteristics of the soil / land that is intended to receive the waste, the

	Compost = PRODUCT or WASTE	Legal basis or standard	Main criteria for 1) compost ceasing to be waste and/or 2) placing on the market and use of compost even under the WASTE regime
			intended application rate and any other relevant issues. Compost derived in whole or in part from animal by-products must be placed on the market and used in accordance with the animal by-products regulations.
	PRODUCT	BSI PAS 100:2005 BSI PAS 100:2005 + Quality Compost Protocol	Scotland: requires certification to PAS 100 (or an equivalent standard), that the compost has certainty of market, is used without further recovery, is not be subjected to a disposal activity and is not be mixed with other wastes, materials, composts, products or additives. Northern Ireland: similar position as Scotland's. England & Wales: both, the Standard and the Protocol have to be fulfilled to sell/supply/use "Quality Compost" as a PRODUCT. Key criteria: • Positive list of allowed input types and source types • QM system including HACCP assessment; standard process including hygienisation • Full documentation and record keeping • Contract of supply per consignment • External quality approval • Soil testing on key parameters • Records of compost spreading by land manager who receives the compost (agriculture and land based horticulture • N.B.: In each country of the UK, if compost 'product' is derived in whole, or in part from animal by-products, placed on the market, stored, used and recorded as required by the Animal By-Products Regulations.

Annex 3: Heavy metal limits in European compost and digestate standards. Source ORBIT/ECN (2008) and stakeholder survey December 2010. Digestate standards are explicitly referred to.

Country	Regulation	Type of standard	Cd	Crtot	CrVI	Cu	Hg	Ni	Pb	Zn	As
			mg/kg d.m.								
AT	Compost Ord.:Class A+ (organic farming)	Statutory Ordinance	0.7	70	-	70	0.4	25	45	200	-
	Compost Ord.:Class A (agriculture; hobby gardening)		1	70	-	150	0,7	60	120	500	-
	Compost Ord.: Class B limit value (landscaping; reclam.) (guide value)*		3	250	-	500 (400)	3	100	200	1,800 (1,200)	-
BE	Royal Decree, 07.01.1998	Statutory decree	1.5	70	-	90	1	20	120	300	-
BG	No regulation	-	-	-	-	-	-	-	-	-	-
CY	No regulation	-	-	-	-	-	-	-	-	-	-
CZ	Use for agricultural land (Group one)	Statutory	2	100	-	100	1	50	100	300	10
	Landscaping, reclamation (draft Biowaste Ordinance) (group two)	Statutory Class 1	2	100	-	170	1	65	200	500	10
		Class 2	3	250	-	400	1.5	100	300	1200	20
		Class 3	4	300	-	500	2	120	400	1500	30
	Fertilizer law 156/1998, ordinance 474/2000 (amended)	**DIGESTATE** with dry matter > 13%	2	100		150	1	50	100	600	20
	Fertilizer law 156/1998, ordinance 474/2000 (amended)	**DIGESTATE** with dry matter < 13%	2	100		250	1	50	100	1200	20
DE	Quality assurance RAL GZ - compost / digestate products	Voluntary QAS	1.5	100	-	100	1	50	150	400	-
	Bio waste Ordinance	Statutory decree (Class I)	1	70	-	70	0.7	35	100	300	-
		(Class II)	1.5	100	-	100	1	50	150	400	-
DK	Statutory Order Nr.1650; Compost after 13 Dec. 2006	Statutory decree	0.8	-	-	1,000	0.8	30	120/60 for priv. gardens	4,000	25
EE	Env. Ministry Re. (2002.30.12; m° 87) Sludge regulation	Statutory	-	1000	-	1000	16	300	750	2500	-
ES	Real decree 824/2005 on fertilisers Class A	Statutory	0.7	70	0	70	0.4	25	45	200	-

Country	Regulation	Type of standard	Cd	Crtot	CrVI	Cu	Hg	Ni	Pb	Zn	As
							mg/kg d.m.				
	Class B		2	250	0	300	1.5	90	150	500	-
	Class C		3	300	0	400	2.5	100	200	1000	-
FI	Decree of the Ministry of Agriculture and Forestry on Fertiliser Products 12/07	Statutory decree	1.5	300	-	600	1	100	100	1,500	25
FR	NFU 44 051	standard	3	120		300	2	60	180	600	
GR	KYA 114218, Hellenic Government Gazette, 1016/B/17- 11-97 [Specifications framework and general programmes for solid waste management]	Statutory decree	10	510	10	500	5	200	500	2,000	15
HU	Statutory rule 36/2006 (V.18)	Statutory Co: 50; Se: 5	2	100	-	100	1	50	100	--	10
IE	Licensing/permitting of treatment plants by competent authority stabilised MBT output or compost not meeting class I or II	Statutory	5	600	-	600	5	150	500	1500	-
	(Compost – Class I)	Statutory	0.7	100	-	100	0.5	50	100	200	-
	(Compost – Class II)	Statutory	1.5	150	-	150	1	75	150	400	-
IT	Law on fertilisers (L 748/84; and: 03/98 and 217/06) for BWC/GC/SSC	Statutory decree	1.5	-	0.5	230	1.5	100	140	500	-
Luxembourg	Licensing for plants		1.5	100	-	100	1	50	150	400	-
LT	Regulation on sewage sludge Categ. I (LAND 20/2005)	Statutory	1.5	140		75	1	50	140	300	-
LV	Regulation on licensing of waste treatment plants (n° 413/23.5.2006) – no specific compost regulation	Statutory =threshold between waste/product	3			600	2	100	150	1,500	50
Netherlands	Amended National Fertiliser Act from 2008	Statutory	1	50		90	0.3	20	100	290	15
PL	Organic fertilisers	Statutory	3	100		400	2	30	100	1500	-
PT	Standard for compost is in preparation	-	-	-	-	-	-	-	-	-	-
Sweden	Guideline values of QAS	Voluntary	1	100	-	100	1	50	100	300	
	SPCR 152 Guideline values	Voluntary	1	100	-	600	1	50	100	800	-
	SPCR 120 Guideline values **(DIGESTATE)**	Voluntary	1	100	-	600	1	50	100	800	-
SI	Decree on the treatment of biodegradable waste (Official Gazette of the Republic of Slovenia, no. 62/08)	Statutory: 1st class*	0.7	80	-	100	0.5	50	80	200	-
		Statutory: 2nd class*	1.5	200	-	300	1.5	75	250	1200	-
		Statutory: stabilized biodegradable waste*	7	500	-	800	7	350	500	2500	-

Country	Regulation	Type of standard	Cd	Crtot	CrVI	Cu	Hg	Ni	Pb	Zn	As
			mg/kg d.m.								
		* normalised to an organic matter content of 30%									
SK	Industrial Standard STN 46 5735 Cl. 1	Voluntary (Mo: 5)	2	100		100	1	50	100	300	10
	Cl. 2	Voluntary(Mo: 20)	4	300		400	1.5	70	300	600	20
UK	UKROFS fertil.org.farming, 'Composted household waste'	Statutory (EC Reg. 2092/91)	0.7	70	0	70	0.4	25	45	200	-
	Standard: PAS 100	Voluntary	1.5	100	-	200	1	50	200	400	-
	Standard: PAS 110 **(DIGESTATE)**	Voluntary	1.5	100	-	200	1	50	200	400	-
EU ECO Label	COM Decision (EC) n° 64/2007 eco-label to growing media COM Decision (EC) n° 799/2006 eco-label to soil improvers	Voluntary [Mo: 2; As: 10; Se: 1.5; F: 200 [only if materials of industrial processes are included]	1	100	-	100	1	50	100	300	10
EU Regulation on organic agriculture	EC Reg. n° 2092/91. Compliacne with limits required for compost from source separated biowaste only	Statutory	0.7	70	-	70	0.4	25	45	200	-

Annex 4: Limits on the content of impurities in compost in national compost regulations and standards. Source ORBIT/ECN (2008) and stakeholder survey December 2010.

Country		Impurities	∅ Mesh size	Limit values % d.m. (m/m)
AT	Compost Ordinance	Total; agriculture	2 mm	≤ 0.5 %
		Total; land reclamation	> 2 mm	< 1 %
		Total; technical use	> 2 mm	< 2 %
		Plastics; agriculture	> 2 mm	< 0.2 %
		Plastics; land reclamation	> 2 mm	< 0.4 %
		Plastics; technical use	> 2 mm	< 1 %
		Plastics; agric. excl. arable land	> 20 mm	< 0.02 %
		Plastics; technical use	> 20 mm	< 0.2 %
		Metals; agriculture	---	< 0.2 %
BE	Royal Decree for fertilisers, soil improvers and substrates	Total	> 2 mm	< 0.5 %
		Stones	> 5 mm	< 2 %
CZ	Act on fertilisers	Total, agriculture	> 2 mm	< 2%
	Biowaste Ordinance	Total, land reclamation	> 2 mm	< 2 %
DE	Bio waste Ordinance	Glass, plastics, metal	> 2 mm	< 0.5 %
		Stones	> 5 mm	< 5 %
ES		Total impurities (glass, metals, plastic)	> 2 mm	< 3 %
FI	Decree of the Ministry of Agriculture and Forestry on Fertiliser Products 12/07	Refuse (glass, metal, plastics, bones, rocks)	---	
		In packaged products		<0.2 % of fresh weight
		Sold in bulk		< 0.5 % of fresh weight
FR	NFU 44-051	Plastic films	> 5 mm	< 0.3 %
		Other plastics	> 5 mm	< 0.8 %
		Metals	> 2 mm	< 2.0 %
HU		No restrictions	---	---
IE	EPA waste license	Total; compost class 1 & 2	> 2 mm	≤ 0.5 %
		Total; low grade compost/MBT	> 2 mm	≤ 3 %
		Stones	> 5 mm	≤ 5 %
IT	DPR 915/82	Total	---	≤ 3
		Glass	---	≤ 3
			---	≤ 1
		Metals	---	≤ 0.5
	Fertil. law	Plastics	< 3.33 mm	< 0.45 %.
		Plastics	> 3.33 < 10 mm	< 0.05 %.
		Other inert material	< 3.33 mm	< 0.9 %
LV	Cabinet Regulation	Total (glass, metal, plastics)	> 4 mm	< 0.5 %

Country	Impurities	∅ Mesh size	Limit values % d.m. (m/m)
No. 530 , 25.06.2006			
NL Fertiliser act + various certification systems	Total Glass Glass Stones	> 2 mm > 2 mm > 16 mm > 5 mm	< 0.5 % < 0.2 % 0 < 2 %
	Biodegradable parts	> 50 mm	0
	Non soil based, non biologically degradable parts		< 0.5 %
SI Decree on the treatment of biodegradable waste (Official Gazette of the Republic of Slovenia, no. 62/08)	Glass, plastics, metal		
	1st class	< 2mm	< 0.5 %
	2nd class	< 2mm	< 2 %
	Stabilized biodegradable waste	< 2mm	< 7 %
	Minerals, stones		
	1st class	< 5mm	< 5 %
	2nd class	< 5mm	< 5 %
	Stabilized biodegradable waste	< 5mm	-
UK PAS 100 voluntary. standard	Total Herein included plastic	> 2 mm	< 0.5 % < 0.25 %
	Stones: other than *'mulch'* Stones: in *'mulch compost'*	> 4 mm > 4 mm	< 8 % < 16 %

Annex 5: Provisions for the exclusion of pathogens, germinating weeds and plant propagules in compost in several European countries. Source ORBIT/ECN (2008) and stakeholder survey December 2010.

	Indirect TIME- TEMPERATURE Regime					Direct methods	
	°C	% H_2O	part. size mm	time	Application area	pathogens / weeds	product (P)/ approval of technology (AT)
ABP Regulation *1069/2009*	70		12	1h	Cat. 3 material	*Escherichia coli OR Enterococcae* *Salmonella*	**Process validation**: < 1000 / g in 4 of 5 samples *1000-5000* / g in 1 of 5 samples **Final Compost:** Absent in 25g in 5 of 5 samples
EC/ 'eco-label' *2006/799/EC 2007/64/EC*					Soil improver growing media	*Salmonella sp.* *E. coli*[54] *Helminth Ova*[54] **Weeds/propagules**	Absent in 25 g < 1000 MPN *(most probable number)*/g Absent in 1.5 g Germinated plants: ≤ 2 plants /l
AT *Statutory 'Guidline – State of the Art of Composting'*	55 – 65 flexible time/temp. regimes are described at min. 55°C 1 to 5 turnings during a 10 – 14 days thermophilic process			10 d	Land reclam. Agriculture Sacked, sport/ playground Technical use Horticulture/ substrates	*Salmonella sp.* *Salmonella sp.* *E. coli* *Salmonella sp.* *E. coli,* *Camylobacter,* *Listeria sp.* --- **Weeds/propagules**	Absent Absent If positive result recommendation for the safe use Absent Absent Absent Absent No requirements Germination ≤ 3 plants /l
BE *VLACO*	60 55			4 d 12 d		*process control* **Weeds**	Time, temp relation Absent
CZ *Biowaste Ordinance*	55 65			21 d 5 d		*Salmonella spp.* *E. coli* *Enterococcae*	Absent < 10^3 CFU / g < 10^3 CFU / g
DE *Biowaste Ordinance*	55 60 [1)] 65 [2)]	40 40 40		14 d 7 d 7 d		*Salmonella senft.* *Plasmodoph. Brass.* *Tobacco Mosaic virus 1* *Tomato seeds* *Salmonella senft.* **Weeds/propagules**	**Process validation** [3)]: Absent Infection index: ≤ 0.5 Guide value bio-test: ≤ 8 /plant Germination rate /sample: ≤ 2% **Compost production**: Absent in 50 g sample Germination ≤ 2 plants/l
DK	55			14 d	Controlled	*Salmonella sp.*	Absent

[54] For those products whose organic content is not exclusively derived from green, garden and park waste

	Indirect TIME- TEMPERATURE Regime					Direct methods	
	°C	**% H_2O**	**part. size mm**	**time**	**Application area**	**pathogens / weeds**	**product (P)/ approval of technology (AT)**
					sanitised compost	*E. coli,* *Enterococcae*	< 100 CFU /g FM < 100 CFU /g FM
ES						*Salmonella sp.* *E. coli*	Absent in 25 g < 1000 MPN *(most probable number)*/g
FI						*Salmonella*	not found in a sample of 25 grams
						Eschrichia coli	1000 CFU/g
						Root rot fungus (for instance Fusarium)	Not ascertainable in substrates used in seedling production
						Globodera riostochiensis and pallida, Clavibacter michicanensis, Ralstonia solanacearum, Synchytrium endobioticum, Rhitzomania, Meloidogyne spp	Not ascertainable in a fertiliser product manufactured from root vegetable, beet and potato raw materia or from topsoil fractions accompanying these to the factory or barking plant.
						Other quarantine pests causing plant diseases	Not ascertainable in fertiliser products manufactured from plant waste or substrates in greenhouse production
FR	60			4 d	Gardening/ retailer	*Salmonella sp.* *Helminth Ova*	Absent in 1 g Absent in 1 g
					Other uses	*Salmonella sp.* *Helminth Ova*	Absent in 25 g Absent in 1.5 g
IE *Green waste*	---	---	---	---	Individual license! 2004	*Salmonella sp.* *Faecal colimforms*	Absent in 50g ≤ 1,000 MPN/g
Catering waste	60		400	2 x 2 d	Individual license! 2007	*Salmonella sp.* *Faecal colimforms*	Absent in 50g ≤ 1,000 MPN/g
Cat3 ABP	70		12	1 h			
IT	55			3 d			
Fertil. law						*Salmonella sp.*	Absent in 25 g sample
						Enterobacteriaceae	≤ 1.0×10^3 CFU/g
						Fecal Streptococcus	≤ 1.0×10^3 MPN/g
						Nematodes *Trematodes* *Cestodes*	Absent in 50 g sample Absent in 50 g sample Absent in 50 g sample
LV *Cabinet Regulation No. 530 25.06.2006*					Fertilisers	*Salmonella sp.* *E. coli*	Absent in 25 g sample < 2500 CFU /g
NL *Beoordeli*	55			4 d		*Eelworms*	Absent

	Indirect TIME- TEMPERATURE Regime				Direct methods		
	°C	% H_2O	part. size mm	time	Application area	pathogens / weeds	product (P)/ approval of technology (AT)
ngsrichtlijn keurcompost						*Rhizomania virus* *Plasmodoph. Brass.* *Weeds*	Absent Absent Germinating plants: ≤ 2 plants/l
PL					All applications	*Ascaris* *Trichuris* *Toxocara* *Salmonella sp.*	Absent Absent Absent Absent
SI Decree on the treatment of biodegradable waste (Official Gazette of the Republic of Slovenia, no. 62/08	55 60 65			14d 7d 7d		*Salmonella sp.*	Absent in 25 g
UK *PAS 100 voluntary standard*	65	50 min. 2 turnings		7 d[4)]	All applications	*Salmonella ssp.* *E. coli* **Weeds/propagules**	Absent in 25 g < 1000 CFU *(colony forming units)*/g Germinating weedplants: 0/l

Annex 6: Regulation of the use of compost. Source ORBIT/ECN (2008) and stakeholders survey December 2010

	Regulation	Requirements or restriction for the use of compost
AT	Compost Ordinance	• Agriculture: 8 t d.m. /ha*y on a 5 year basis • Land reclamation: 400 or 200 t d.m. /ha*y within 10 years depending on quality class • Non food regular application: 20 or 40 t d.m. /ha*y within 3 years dep. on quality class • El. Conductivity > 3 mS/cm: excluded from marketing in bags and for private gardening
	Water Act	• Specific application requirements pursuant to the Action Programme following the EU Nitrate Directive (e.g. limitation to 210 or 170 kg total N per hectare an year)
BE *Flanders*	Royal decree for fertilisers, soil improvers and substrates Fertiliser Regulation (nitrate directive) VLAREA waste regulation	• An accompanying document with user information is obligatory. • Fertiliser Regulation limits N and P, partly more compost use possible because of beneficial soil effects compared to manure. • VLAREA require VLACO Certificate for use and limits max. level of pollutants and show conditions for max application rates
BG	No data available	n.d.
CY	No data available	n.d.
CZ	Biowaste Ordinance, Waste Act (2008)	• According to the coming Biowaste Ordinance (2008) for the first class there are restrictions according to Ordinance on hygienic requirements for sport areas, the 2nd best can be used with 200 t d.m/ha. in 10 years.
	Fertiliser law	• Fertiliser law requires application according to good practice.
DE	Biowaste Ordinance (BioAbfV 1998) Soil Protection Ordinance (BbodSchV 1999) Fertiliser Ordinance (DÜMV, 2003)	• The Biowaste Ordinance regulates agricultural use with compost Class I 20 t d.m. in 3 years, Class II 30 t d.m. in 3 years. • Soil Protection Ordinance for non agricultural areas between 10 and 65 t d.m. compost depending on use. • Fertilising with compost according to good practice
DK	Stat. Order 1650 0f 13.12.06 of the use of waste (and sludge) in agriculture	• 7 t d.m. /ha*y on a 10 year basis • Restriction of nitrogen to 170 kg /ha*y • Restriction of phosphorus to 30 kg /ha*y average over 3 years • The levels for heavy metals and organic compounds are restricted in the INPUT material for the composting process
EE	No compost restrictions	Only restrictions for the use of stabilized sludge "sludge compost"
ES	Real Decree 824/2005 on Fertiliser Products	• Class C compost (mixed waste compost) 5t d.m./ha*y
FI	Decree of the Ministry of Agriculture and Forestry on Fertiliser Products 12/07	• Maximum Cd load/ha 6 g during 4 years (crop growing area), 15 g during 10 years (landscape gardening), 60 g during 40 years (forestry); • Soluble phosphorus load per 5 years 400 kg (farming), 600 (horticulture) and 750 (landscape gardening); soluble nitrogen load during 5 years in landscape gardening max. 1250 kg.
FR	Organic soil improvers - Organic amendments and supports of culture NFU 44-051	From the moment a compost meets the standard NFU 44-051 there is no rule for the use. In the standard, flows in heavy metals, and elements are restricted to the maximum loading limits: • Per year g/ha: As 270, Cd 45, Cr 1,800, Cu 3,000, Hg 30, Ni 900, Pb 2,700, Se 180, Zn 6,000 • Over 10 years g/ha: As 900, Cd 150, Cr 6,000, Cu 10,000, Hg 100, Ni 3,000, Pb 9,000, Se 600, Zn 30,000 • Application should follow good agrarian practices, and agronomical needs which are taken into account for the use of composts.

	Regulation	Requirements or restriction for the use of compost
GR	Common National Ministerial Decision 114218/1997 Hellenic Ministerial Decision	Upper limits for amounts of heavy metals disposed of annually in agricultural land Cd 0,15, Cu 12, Ni 3, Pb 15, Zn 30, Cr 5, Hg 0,1, kg/ha/y
HU	49/2001 Statuory Rule about the protection of the waters and groundwaters being affected by agricultural activities 10/2000. (VI. 2.) KöM-EüM-FVM-KHVM - Water protection rule	• Compost application on agricultural land is limited by the amount of nutrient with 170 kg/ha Nitrogen. • Dosage levels depending on background contamination and nutrient content level in the soil laid down in the National Statutory Rule about the threshold values for the protection of the ground- and subsurface waters and soils.
IE	Statutory Instruments SI No. 378/2006 Good agricultural practice for protection of waters: Statutory instrument 612 of 2006	• IE Nitrate regulation: Compost has to be included in the Nutrient Management Plan. Availabilty of nutrients calculated like cattle manure. • There are specific waiting periods to consider for animal access to land fertilised with biowaste compost based on the Animal-By-Product Regulations. o Catering waste: 21 d for ruminant animals; 60 d for pigs; o Former foodstuff & fish waste compost: 3 years (under revision)
IT	National law on fertilisers L. 748/84 (revised in 2006 with the new law on fertilisers, D.lgs. 217/06) Regional provisions	• Compost has to be considered a product to be used according only to Good Agricultural Practice as long as it meets the standards. No restriction is set on loads for unit area • Some regions have codified approaches for low grade materials applications and landfill reclamation, building on the old regulation on “mixed MSW compost” (DCI 27/7/84)
LT	Environmental Requirements for Composting of biowaste, approved by the Ministry of the Environment on 25 January 2007, No. D1-57 Standards for sewage sludge use for fertilising and redevelopment LAND 20-2005 (Gaz., 2005, No. 142-5135)	• When compost used for improve the quality of the soil, the annual quantity of the heavy metals can not exceed norms according LAND 20-2005. • Compost application in agriculture and or soil reclamation purposes, is restricted by contamination with pathogenic microorganisms, organic micropollutants and heavy metals (according to LAND 20-2005) • Compost application on agricultural land is limited by the amount of nutrient with 170 kg/ha Nitrogen and 40 kg/ha Phosphorous per year
LU	EU Nitrate Directive	• No specific regulations; advise (voluntary): 15 t d.m. /ha *y • Only record keeping about the compost use and send to the Ministry
LV	No regulations	only for sewage sludge compost
MT	No data available	
NL	Fertiliser Act (2008)	• Compost has to meet the national standard (heavy metals) • In the new fertiliser legislation limitations for application are only based on the nutrient content for agriculture max. 80 kg P_2O_5 /ha*y and 120 to 250 kg N /ha*y depending on the crop consumption • For some crops which grow in the soil (e.g. potatoes) compost needs certification and a low glass content < 0.2 %
PL	The National Law on Fertilisers and Fertilization. 26.07.2000. Dz. U. Nr 89, poz. 991	There are limits specified in regulations for amounts of composts applied to soil. There are no limits for nitrogen but only for manures. Composts shall be applied according to good agricultural practice
PT	No regulations available	---
RO	No data available	n.d.
SE	The Swedish Board of Agriculture:	• Fixed maximum heavy metal load Maximum heavy metal load (g/ha*y): Pb 25; Cd 0.75; Cu 300; Cr 40; Hg 1.5;

	Regulation	Requirements or restriction for the use of compost
	SJV 1998:915 (sewage sludge regulation)	Ni 25; Zn 600
	Nitrate directive	Agriculture: nitrogen: 150 kg/ha*y and phosphorus: 22 – 35 kg/ha*y
SI	Decree on the treatment of biodegradable waste (Official Gazette of the Republic of Slovenia, no. 62/08)	• Class I can be used without any restrictions. • Class II can be spread with a special permission with a limited application rate considering the heavy metal content and load after an evaluation and risk assessment performed by a lab (but not more than 10 t d.m./ha /year).
	Decree concerning the protection of waters against pollution caused by nitrates from agricultural sources (Official Gazette of the Republic of Slovenia, no. 113/09)	• Application of organic fertilizer on agricultural land is limited by the amount of nutrient with 250 kg/ha Nitrogen.
SK	Act No. 220/2004 Col. on protection and using of agricultural soils	• Lays down limit concentrations of risk elements in agricultural soils
	Ministry of Agriculture Decree No. 26/2000, on fertilisers.	• Lays down fertiliser types, max. concentration of risk elements in organic fertilisers, substrates and commercial fertilisers, storage and take-off conditions, and methods of fertiliser testing
UK	Each country of the UK has different requirements Here is an example of parts of the regulations applicable for England and Wales	• Use in agriculture and applications to soil other than land restoration**:** A Waste Management Licence Exemption, Paragraph 7A, must be obtained by the land owner/manager before accepting and storing then spreading compost. The compost must be made from source segregated biowaste. Per Paragraph 7A exemption: • ‘Benefit to agriculture’ or ‘ecological improvement’ must be demonstrated, which is done by spreading compost as per Nitrate Vulnerable Zone regulations if within a NVZ, and following the Codes of Good Agricultural Practice for the Protection of Soils and Water. Given the typical total nitrogen content of ‚Green compost‘, the application rate would be approximately; • 30 - 35 fresh tonnes per hectare per year where a field NVZ limit of 250 kg total nitrogen per hectare applies, • 30 fresh tonnes per hectare per year if ‚Not NVZ‘ but as per good agricultural practice, or • 60 – 70 fresh tonnes per hectare once per two years if ‚Not NVZ‘ but as per good agricultural practice. • If the compost is classed as a waste, the Environmental Permitting Regulations apply (paragraph 7 exemption, U10 exemption or Standard Rules Permit) and a permit or exemption will be required by the land owner/manager before storing or spreading the compost. If the compost has ceased to be waste
		• Voluntary Code of Good Agricultural Practice for the Protection: limitation of nitrogen of 250 kg /ha/y (for all types of ‘organic manure’ used, including composts); compost can also be applied at a rate of 500 kg/ha once per two years

Annex 7: Admissible maximum dosage of heavy metals to the soil in national legislation and standards [g/ha* y]. Source ORBIT/ECN (2008) and stakeholder survey December 2010.

Country		Cd	Cr_{tot}	Cr^{VI}	Cu	Hg	Ni	Pb	Zn	As	Se
		[g/ha y]*									
EC	**'Sewage sludge'** 1) 10 y basis	150	3,000	-	12,000	100	3,000	15,000	30,000	-	-
AT	Sewage sludge 2) Fertiliser. Ord. 2 years basis	20 5	1,250 300	- -	1,250 350	20 5	250 200	1,000 300	5,000 1,500	- -	- -
BE	VLAREA (comp.) yearly	12	500	-	750	10	100	600	1,800	300	-
CY	No data available	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
CZ	Sewage sludge yearly *max. 5 t d.m./3y in agriculture*	5	200		500	4	100	200	2,500	30	
DE 1)	sewage sludge	16	1,500	-	1300	13	300	1,500	4,100	-	-
DK	7 t d.m. basis / calculated related to 30 kg P_2O_5/ha / calculated	5.6 3	700 -	 -	7,000 -	5.6 6	210 75	840 300	28,000 -	- -	- -
EE	No data available	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
ES	RD 1310/1990 (SS) 10 years basis	150	3,000		12,000	100	3,000	15,000	30,000	-	-
FI	Sewage sludge Decree of the Ministry of Agriculture and Forestry on Fertiliser Products 12/07 (average based on 4,10 or 40 years application)	3 1.5	300		600	2	150	150	1,500	-	-
FR	NF U 44 51 (comp.) 10 years basis NF U 44 51 (comp.) yearly	15 45	600 1,800		1,000 3,000	10 30	300 900	900 2,700	3,000 6,000	90 270	60 180
GR	No data available	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
HU	Sewage sludge (under Nr. 50/2001.)	150	10,000	-	10,000	100	2,000	10,000	30,000	500	1,000
IE	SI 148/1998 [use of sewage sludge in agriculture]	10	1000	-	1000	10	300	750	2500	-	-
IT	DCI 27/07/84 - MWC from mixed waste	15	2,000	15	3,000	15	1,000	500	10,000	100	-
LT	No data available	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
LU	No regulation	-	-	-	-	-	-	-	-	-	-
LV	Sewage sludge	30	600		1,000	8	250	300	5,000		
MT	No data available	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
NL	Nutrient loads (N,P) are the dosage limiting factor	-	-	-	-	-	-	-	-	-	-
PL	Sewage sludge	20	1,000		1,600	10	200	1,000	5,000	-	-
PT 1)	Sewage sludge /10 y basis	150	4,500		12,000	100	3,000	15,000	30,000	-	-
RO	No data available	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.	n.d.
SE	SNFS 1992:2 (sewage sludge)	0.75	40		300	1.5	25	25	600	-	-
SI	Sewage sludge use in agriculture on 10 year basis	15	2000	-	3000	15	750	2500	12000	-	-
SK	No regulation	-	-	-	-	-	-	-	-	-	-
UK	Sludge (use in agriculture) Regulations 3) sewage sludge	150	?	-	7,500	100	3,000	15,000	15,000	-	-

	average annual loading over 10 years										

[1)] Directive 86/276/EEC; average within 10 years [2)] Sew. Sludge Ordinance, Lower Austria (Class III)

[3)] S(UiA)regulations: Statutory Instrument 1989 No. 1263, The Sludge (Use in Agriculture) Regulations 1989

The QCP (England and Wales) sets maximum allowable concentrations for PTEs in soils that receive Quality Composts, as specified in the Sludge (Use in Agriculture) Code; these are more stringent than the soil PTE maximum allowable concentrations allowed in the regulations.

SS … sewage sludge

Annex 8: Compost quality assurance schemes in EU Member States. Source ORBIT/ECN (2008).

Country (Quality label)	Status of quality assurance activities and certification/quality assurance organisation
AT	Fully established quality assurance system based on Austrian Standards ÖNORM S2206 Part 1 and 2 and Technical Report ONR 192206 published by the Austrian ÖNORM Standardisation Institute. Up to now two non-profit associations have adopted these standards for granting a compliance certification with the QAS: • the Compost Quality Society of Austria KGVÖ (Kompostgüteverband Österreich) • the Compost & Biogas Association – Austria (ARGE Kompost & Biogas – Österreich) The certification schemes comprise both, operational process and quality management and final product approval. Thereby the most important references are the requirements set by the Austrian Compost Ordinance which provides for a comprehensive documentation and monitoring programme. Compost can get product status if it meets one of the 3 classes based on precautionary requirements (class A+ (top quality for organic farming), class A "Quality compost"(suitable for use in agriculture, horticulture, hobby gardening and Class B (minimum quality for "compost" restricted use in non-agricultural areas) Under the roof of **Compost Quality Society of Austria (KGVÖ)** large scale compost producers supplemented by experts, grant an additional quality seal for the marketing of high quality composts on the basis of the officially acknowledged quality assurance system. External labs collect the samples and analyses. Evaluation of the results, documentation and granting of the label is carried out by an independent quality committee with expert members of the KGVÖ. (16 members - 300.000 t capacity) **Compost & Biogas Association Austria (ARGE** Kompost & Biogas) was founded to establish the decentralised composting of separately collected biowaste in cooperation with agriculture (on-farm composting). Nowadays the association has grown to a full-scale quality assurance organisation on the basis of the common Austrian standards. ARGE uses external auditors for sample taking, plant inspection, evaluation, documentation and certification of the plants. (370 members - 300.000 t capacity)
BE	Fully established statutory quality assurance system for compost in the Flanders region operated by the non-profit **Flemish compost organisation VLACO vzw** with its members from municipalities, government and composting plants. (Around 40 green and biowaste plants with 840.000 t of capacity). Based on the Flemish Regulation on Waste Prevention and Management VLAREA act VLACO vzw show a very unique but effective integrated approach and a broad range of tasks. The organisation executes: 1. Waste prevention and home composting programmes 2. Consultation and advice for process management incl. co-composting and co-digestion 3. Sampling, organisation of the analysis and evaluation of the results 4. Organisation of field trials and development of application information 5. Marketing and Public Relation for organic waste recycling and first of all for the compost So by means of this integrated approach the whole organic loop from source material to the use of the final product is in one hand. Nevertheless some modifications are made lately in order to include elements of ISO 9000 and the Total Quality Management TQM the quality assurance of anaerobic digestion residuals and of manure into the system. Not only the end-product is controlled but the whole process is followed up. In TQM the input (the bio or green waste), the process and the output are monitored and analysed. The reason to put standards on the input is that this allows no dilution. Depending on source materials and product characteristics up to 15 different products can be certified (statutory) and labelled (voluntarily) by VLACO vzw.
CZ	Voluntary quality assurance scheme proposed by the regional **Environmental and Agricultural Agency ZERA** is in preparation for a quality assurance scheme for 2008 after new biowaste Ordinance is in force. Main task is to create a compost market by certifying compost products and organise a practical inspection and control of compost. The certification scheme is based on requirements of the Czech institute of accreditation in the agreement with international norm CSN EN ISO/ IEC 45011:1998.
DE	Fully established voluntary quality assurance system for compost and anaerobic digestion residuals in which the **Compost Quality Assurance Organisation (Bundesgütegemeinschaft Kompost BGK)** organisation is the carrier of the RAL compost quality label. It is recognised by RAL, the German Institute for Quality Assurance and Certification, as being the organisation to handle monitoring and controlling of the quality of compost in Germany.

Country (Quality label)	Status of quality assurance activities and certification/quality assurance organisation
	The BGK was founded as a non-profit organisation in order to monitor the quality of compost. Through consistent quality control and support of the compost producers in the marketing and application sectors, the organisation promotes composting as a key element of modern recycling management. 425 composting and 67 digestion plants with 5.9 mio t capacity plants take part in the quality assurance system and have applied for the RAL quality label. Besides the central office, a quality committee works as the main supervision and expert body in the quality assurance system. In addition BGK runs a database with all indicators of the composting plants and analyses results of the products. Meanwhile it includes more than 35.000 data sets. The BGK has defined a general product criteria quality standard (the RAL quality label GZ 251 for fresh and mature compost as well as for compost for potting soil compost and for different types of digestion residuals RAL GZ 245 (new since 2007 RAL GZ 246 for digestion products residuals from treatment renewable resources (e.g. energy crops)) and established a nationwide system for external monitoring of plants and of compost and digestion products. The quality assurance system comprises the following elements: Definition of suitable input in accordance with biowaste and fertiliser regulation. • Operation control by plant visits of independent quality managers. ▪ External and internal monitoring ▪ Quality criteria and quality label do demonstrate the product quality; ▪ Compulsory declaration and information on correct application; ▪ Documentation for the competent authorities. The successful work is respected by the authorities in Germany by exempting member plants from some control requirements which are subject to the waste legislation. By means of that procedure quality assured compost show a "quasi" product status in Germany.
DK	A quality assurance system for compost (quality criteria, standardised product definition, analysing methods) is prepared by **DAKOFA (Danish Association on waste management)** but is not applied. No further progress expected for the moment because separate collection of kitchen waste will not increase before the present legal background. Green waste collection and composting is very well diffused but not subject to any waste and quality standards regulation in Denmark.
ES	Draft statutory Spanish standard on compost legislation, laying down standardised, nationwide rules concerning the production, marketing and labelling of compost as a product prepared by the Ministry of Environment. A lot of studies confirmed for Spain the need to improve the compost quality in order to open up markets. This was in the outcome of a LIFE Project too deemed to investigate the production and use of quality compost in Andalusia. Based on the results the **Andalusia´s Regional Ministry of Environment** has designed and registered a trademark *"Environmental Accreditation of Compost"* that allows - on a voluntary basis - companies producing compost to show its quality. The Order 20/07/07 Environmental Accreditation of Compost Quality. BOJA nº 156 8/8/2007 explains how to get and use it .Compost should fulfil some limits according to the Real Decret 824/2005, 8/7/05, about fertilisers. It is the Andalusia´s Regional Ministry of Environment who will control the label use and define accredited laboratories to analyse compost samples. There is no independent sample taking.
HU	Voluntary Hungarian Compost Quality Assurance System is prepared (but not implemented) by the Hungarian Compost Association and waiting for the revision of the existing regulations which are intended for sewage sludge and fertilisers and are not applicable for composting. The **Hungarian Compost Association** has completed in 2006 the framework of the assurance system (similar to the German BGK and Austrian KGVÖ examples) and is now waiting for the new Hungarian Statutory rule about production, nominating, marketing and quality assurance for composts. Basic elements of the future Compost Quality Assurance Systems (implementation in 2009) are: 1. Raw material list (permissive list) 2. Compost Classes The Ordinance will define three different quality classes for compost based on the contaminant content. Will also define ways of utilisation. The classes (similar to the Austrian ones) will be: Class A - top quality (suitable for organic farming use) Class B - high quality (suitable for agricultural use) Class C - minimum quality (not suitable for agricultural use) 3. Quality control End-product controlling and process controlling. Independent sample taking and analysis is intended.
IE	A first draft for a voluntary compost quality standard was presented in Ireland (2007). This task and the follow up establishment of a quality assurance system are elements of the national Market Development Plan

Country (Quality label)	Status of quality assurance activities and certification/quality assurance organisation
	- intended to create market for recyclables - have recently started. The **Irish Composting Association CRE supports** is involved in these developments. Limits for pollutants, stability, etc. are specified in waste authorisations (e.g. EPA Waste licences and Local Authority waste permits).
IT	Voluntary quality assurance on operated by the **Italian Compost Association CIC,** the Italian National Association for the compost industry. It started as certification system for compost products in order to show compliance with the national fertiliser regulation and the statutory quality standards for green and mixed compost are laid down there. No monitoring of the standard is proposed. Basically, the quality label ensures fulfilment of statutory standards (assessment of compliance is usually an issue due to the rather poor performance of controlling authorities, hence CIC aims to reinforce the “declaration of compliance”).Within the scheme samplings are made by certificated personnel from the Italian Composting Association (CIC) and analyzed at a single accredited laboratory. Now the scheme turns step by step into a quality assurance system e.g. with preparation of certifying the entire production process and above all (as requested by consumers) the traceability of compost. The CIC Quality Label is considering this to be a very important initiative for the industry because it provides an independent element of security upon which consumers and operators can make their choices. Currently, the quantities of compost that can be certified amount to approx. 250,000 tons /y, which represents approximately 20% of the Italian production.
LU	Statutory system which relies on the German Quality Assurance System and on the German Organisation **(Bundesgütegemeinschaft Kompost e.V. BGK).** The request to execute a "quality assurance system like the one of BGK or similar" is part of the licensing procedure for every composting plant. Missing alternatives have established the BGK system in Luxembourg as the one and only. All independent sampling, control functions and documentation functions will be executed by the BGK representatives. (5 compost plants with around 50.000 t/y total capacity are part of the scheme)
LV	On the starting stage (from Nov. 2006), quality assurance organization Environmental Agency
NL 1.1	After 10 years of experiences the Dutch Government decided that not the quality but the nutrients are the primary precautionary problems with compost. Less strict heavy metal thresholds and no obligations for control any more is one result. In addition no longer is the applied amount of compost but the nutrient load limited. All compost which is used for crops which grow in the soil must be independently certified with a very strict threshold for glass. Because the sales area of compost is not predictable while the production, more or less all biowaste composts, will be certified in future and compost certification will become quasi statutory. For vegetable, fruit and garden VFG waste the certification is operated by independent institutes/auditors with independent sample takers in cooperation with the Dutch Waste Management Association DWMA/VA. The around 20 VA members treat 1.5 mio VFG waste from separate collection. This new scheme will replace the former costly KEUR certification system operated by the Dutch certification system KIWA. The BVOR Dutch Association of Compost Plants manages the certification system in both the green waste and VFG sectors which doesn't require external sampling but independent institutes/auditors for the evaluation of the process and the analysis results. 50 green waste composting plants with 1.8 mio tons of capacity are member of the BVOR.
PL	Quality Assurance refers only to the final product. The Ministry of Agriculture and Rural Development gives the certificate of organic fertiliser based on its chemical properties and pathogen status after the compost receives a positive expertise from the designated institution (depending on planned application area).
SE	Voluntary quality assurance system for compost and digestion products is operated by the **Swedish Waste Management Association Avfall Sverige** together with Swedish Standardisation Institute SP. For the moment Sweden has no statutory standard, but the necessity of standards is seen clearly by involved parties and the government. Producers and users are of the opinion that sustainable recycling of organic wastes demands clear regulations regarding what is suitable to be recycled and how it should be managed and controlled. A well-founded quality assurance programme definitely increases sustainable recycling of organic wastes. The regulations for the voluntary Swedish certification of compost and digestion residues are based on purely source-separated organic waste, with special emphasis on the acceptability of raw materials

Country (Quality label)	Status of quality assurance activities and certification/quality assurance organisation
	for input, the suppliers, the collection and transportation, the intake, treatment processes, and the end product, together with the declaration of the products and recommendations for use. 6 digestion and 1 composting plant are included in the certification system and have applied for the certificate.
UK COMPOSTING ASSOCIATION CERTIFIED	Voluntary standard BSI PAS 100 and the supplementing Quality Compost Protocol (QCP) set criteria for the production and minimum quality of quality composts. The **UK Composting Association** owns a certification scheme aligned to BSI PAS 100, which has been upgraded to incorporate the additional requirements of the QCP. Composting plants and compost particle size grades that meet all the requirements can get their composts certified and use the Composting Association's quality mark. Around 150 composting producers are under assessment, treating more than 2 mio t of source segregated bio and green waste, and 40 % of the compost they produce is already certified. BSI PAS 100:2005 specifies the minimum requirements for the process of composting, the selection of materials from which compost is made, minimum compost quality, how compost is labelled and requires that it is traceable. It also requires Hazard Analysis and Critical Control Point assessment, the implementation of a compost Quality Management System and correct compost labelling and marking. Compliance with requirements of the QCP is considered sufficient to ensure that the recovered biowaste may be used without risk to the environment or harm to human health and therefore without the need for waste regulatory control. In addition, The Quality Compost Protocol requires compost certification to PAS 100 and also imposes restrictions on materials from which quality composts can be made and in which markets they can be used as ‘product’. The QCP also requires the producer to supply customers with contracts of supply, and if Quality Compost is stored and used in agriculture or field horticulture, this must be done in accordance with the Codes of Good Agricultural Practice and that soil PTE concentrations do not exceed the Sludge Use in Agriculture Code’s limits. The Quality Protocol further aims to provide increased market confidence in the quality of products made from biowaste and so encourage greater recovery of source-segregated biowaste. In England and Wales, compost must be independently certified compliant with both PAS 100 and the Quality Compost Protocol for it to be supplied to the designated market sectors as a ‘product’. In Scotland, for compost to be supplied as a ‘product’ it must be certified to PAS 100 (or an equivalent standard), have certainty of market, be used without further recovery, not be subjected to a disposal activity and not be mixed with other wastes, materials, composts, products or additives. Northern Ireland’s position is currently similar to Scotland’s. Compost can be placed on the market as a recovered waste material in any of the countries of the UK; in this circumstance, waste management licensing regulation requirements must be adhered to. A number of local authorities have required PAS 100 certification in contracts with compost producers, and in England and Wales in particular, may start requiring certification to the Quality Compost Protocol as well.

Annex 9: Biodegradable wastes that are currently regarded as suitable for composting in one or more Member States

Country codes in […] indicate that the use of this waste as input material for composting is connected with certain restrictions for marketing and use or that specific quality requirements must be met. See also footnotes.

	Type of waste material	Further specifications	EWC Code	Corresponding EWC waste type	Input materials accepted by MS
1	**Waste for biological treatment from exclusively vegetable origin (*NO animal by-products or meat*)**				
1.1	**Organic vegetable waste from garden & parks and other greens**				
1.1.01	Mixtures from organic wastes according to 1.1	corresponds to VFG = vegetable, fruit & garden waste; source separated	n.s.	n.s.	AT, BE, BG, CZ, DE, FR, HU, IE, NL, PL, SE, SI, UK
1.1.02	Grass cuttings, hay, leaves,	Only slightly contaminated cuttings (not along highly frequented streets and highways	20 02 01	Compostable waste	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LT, LU, LV, NL, PL, SE, SI, SK, UK
1.1.03	Leaves,	Only slightly contaminated (not along highly frequented streets and highways	20 02 01	Compostable waste	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, LV, NL, PL, SE, SI, SK, UK
1.1.04	Vegetable waste, flower waste, windfalls	Also cut flowers from florist markets and households	20 02 01 02 01 03	Compostable waste Waste from vegetable tissue	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, LV, NL, PL, SE, SI, SK, UK
1.1.05	Bark	Only bark not treated with lindane	03 01 01[55] 03 03 01	Bark and cork waste Waste from wood preparation and the production of cellulose, paper and cardboard	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LT,LU, NL, PL, SE, SI, SK, UK
1.1.06	Wood , not specified	Only untreated wood;	03 01 05	Saw dust, wood shavings, cuttings, wood, chipboard, veneer with the exception of those which belongs to 03 01 04	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, [IT][56], LT, PL, SE, SI, SK, UK
1.1.07	Wood, tree and bush cuttings	Complete or shreddered	20 01 38 20 02 01	Wood with the exception of those which belong to 20 01 37 Biodegradable waste	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, [IT] [57], LT, LU, NL, PL, SE, SI, SK, UK
1.1.08	Wood, from the processing of untreated wood	Only untreated wood	03 01 05	Saw dust, wood shavings, cuttings, wood, chipboard, veneer with the exception of those which belong to 03 01 04	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, [IT][57], LT, LU, NL, PL, SE, SI, SK, UK
1.1.09	Cemetery waste – source separated		20 02 01	Biodegradable waste	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK
1.2	**Vegetable waste, from the preparation and consumption of food, luxury food & beverages**				
1.2.01	Cereals, fruit & vegetables		20 02 01 02 01 03	Compostable waste Waste from vegetable tissue	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK
1.2.02	Tea leaves, coffee grounds		20 02 01 02 01 03	Compostable waste Waste from vegetable tissue	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK
1.2.03	Dough, yeast		20 02 01 02 01 03	Compostable waste Waste from vegetable tissue	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK
1.2.04	Residues from spices and herbs		20 02 01 02 01 03	Compostable waste Waste from vegetable tissue	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK

[55] Waste from wood processing and the production of plates and furniture
[56] To be specifically approved for each plant
[57] To be specifically approved for each plant

	Type of waste material	Further specifications	EWC Code	Corresponding EWC waste type	Input materials accepted by MS
1.2.05	Wooden oversize fraction from screening compost for reuse in composting		n.s.	n.s.	AT, BE, BG, CZ, DE, ES[58], FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, UK
1.2.06	Former foodstuff	Of vegetable origin only	02 01 03 02 03 04[59]	Waste from vegetable tissue Materials not suitable for consumption or processing	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, UK
1.2.07	Vegetable catering waste and used cooking oil	Of vegetable origin only (plant tissue) source separated from central as well as household kitchens as well as catering services	02 01 03 02 03 04[60]	Waste from vegetable tissue Materials not suitable for consumption or processing	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, UK
1.3	**Organic residues from commercial, agricultural and industrial production, processing and marketing of agricultural and forestry products – purely of vegetable origin**				
1.3.01	Harvest residues, hay and silage		02 01 03[61]	Plant-tissue waste	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LT, LU, NL, PL, SE, SI, SK, UK
1.3.02	Bark		02 01 03[61]	Plant-tissue waste	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK
1.3.03	Grain/Cereal dust		02 01 03[61]	Plant-tissue waste	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK
1.3.04	Straw		02 01 03[61]	Plant-tissue waste	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK
1.3.05	Vines		02 03 04	Materials not suitable for consumption or processing	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK
1.3.06	Tobacco waste		02 03 04	Materials not suitable for consumption or processing	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK
1.3.07	Beet chips, tails		02 01 03[61] 02 03 04	Plant-tissue waste Materials not suitable for consumption or processing	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK
1.3.08	Residues from canned and deep freeze food processing		02 03 04	Materials not suitable for consumption or processing	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK
1.3.09	Residues from fruit juice and jam production		02 03 04	Materials not suitable for consumption or processing	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK
1.3.11	Residues from starch production		02 03 04	Materials not suitable for consumption or processing	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK
1.3.12	Vinasse, molasse residues		02 03 04	Materials not suitable for consumption or processing	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK
1.3.13	Feed and feed residues not fit for use	Of vegetable origin only	02 01 03[61]	Plant-tissue waste	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK
1.3.14	Residues of tea and coffee production		02 03 04	Materials not suitable for consumption or processing	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LU, NL, PL, SE, SI, SK, UK
1.3.15	Marc, seeds, shells, grist, press-cake	e.g. from oil mills, spent barley, draff of hop; marc of medicinal plants, copra, only materials which have not been treated with organic extraction agents	02 03 01	Sludge from washing, cleaning, peeling, centrifuging and segregation processes	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, IT, LT, LU, NL, PL, SE, SI, UK[62]
1.3.16	Crushed grain or process		02 03 01	Sludge from washing,	AT, BE, BG, CZ, DE, ES, FI,

[58] Not considered because it not appears in European waste list, but presumably it would not be of any problem to include it
[59] Waste from the preparation and processing of fruit, vegetables, grain, cooking oil, cacao, coffee, tea and tobacco, from canned food production, yeast production and preparation of molasses
[60] Waste from the preparation and processing of fruit, vegetables, grain, cooking oil, cacao, coffee, tea and tobacco, from canned food production, yeast production and preparation of molasses
[61] 02 01: **Waste form agriculture, horticulture, fish farming, forestry, hunting and fishing**
[62] allowed in PAS 100 (BSI, 2005) but not yet in Quality Compost Protocol (Environment Agency, 2007)

	Type of waste material	Further specifications	EWC Code	Corresponding EWC waste type	Input materials accepted by MS
	residues			cleaning, peeling, centrifuging and segregation processes	FR, HU, IE, IT, LT, LU, NL, PL, SE, SI, UK[62]
1.3.17	Fruit, cereal and potato draff	From breweries and distilleries	02 03 01	Sludge from washing, cleaning, peeling, centrifuging and segregation processes	AT, BE, BG, CZ, DE, ES, FI, FR, IE, IT, LT, LU, NL, PL, SE, SI, SK, UK[62]
1.3.18	Filtration ditomite		n.s.	n.s.	AT, PL
1.3.19	Uncontaminated sludge or residues of press filters from separately collected process water of the food, beverage, tobacco and animal feed industry	From vegetable, fruit and plant tissue processing only		Sludge from washing, cleaning, peeling, centrifuging and segregation processes	AT, PL, UK[62]
1.3.20	Eventually slightly polluted sludge from the food and fodder industry exclusively of vegetable origin		02 03 01 02 03 05	Sludge from washing, cleaning, peeling, centrifuging and segregation processes Sludge from company owned waste treatment	AT, BE, BG, CZ, DE, ES, HU, IE, IT, NL, PL, [SE], SI, UK[62]
1.3.21	Eventually slightly polluted pressfilter, extraction and oil seed residues from the food and fodder industry exclusively of vegetable origin		02 03 04	Materials not suitable for consumption or processing	AT, BE, BG, CZ, DE, ES, FR, HU, IE, IT, NL, PL, [SE], SI, UK[72]
1.3.22	Wastes from the production of alcoholic and non-alcoholic beverages (except coffee, tea and cocoa'		02 07 01	Wastes from washing, cleaning and mechanical reduction of raw materials	CZ, ES, PL, SI, UK,
1.3.23			02 07 02	Wastes from spirits distillation	CZ, ES, PL, SI, UK
1.3.24			02 07 04	Materials unsuitable for consumption or processing	CZ, ES, PL, SI, UK
1.3.25			02 07 99	Wastes not otherwise specified	SI, UK
1.3.26	Spoilt seeds		02 01 03	Plant-tissue waste	AT, BE[63], BG, CZ, DE, ES, FI, FR, HU, IE?, IT, LU, NL, PL, SE, SI, UK
1.3.27	Wood, tree and bush cuttings	Complete or shreddered	20 01 38 20 02 01	Wood with the exception of those which belong to 20 01 37 Biodegradable waste	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, [IT] [64], LU, NL, SE, SI, SK, UK
1.3.28	Wood, from the processing of untreated wood	Only untreated wood	03 01 05	Saw dust, wood shavings, cuttings, wood, chipboard, veneer with the exception of those which belong to 03 01 04	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, [IT][57], LU, NL, PL, SE, SI, SK, UK
1.3.29	Wood – sawdust	Only untreated wood	03 01 05	Saw dust, wood shavings, cuttings, wood, chipboard, veneer with the exception of those which belong to 03 01 04	AT, BE, BG, CZ, DE, ES, FI, FR, HU, IE, [IT][57], LU, NL, PL, SE, SI, SK, UK
1.4	**Other Organic residues – purely of vegetable origin**				
1.4.01	Sub-aqua plants; sea weed		02 01 03	Plant-tissue waste	AT, BE[63], BG, CZ, DE, ES, FI, FR, HU, IE?, IT, LT, LU, NL, PL, SE, SI, UK
1.4.02	Micelles from antibiotics production		16 03 06	Organic waste with the exception of those listed under 16 03 05	AT, BE[65], CZ, DE, NL, PL, SE, SI
1.4.03	Biodegradable packaging and bioplastics		07 02 13, 15 01 02, 15 01 05	waste plastic plastic packaging composite packaging	AT[66], BG, DE, ES, FI, FR, HU, IE, IT, LT, LU, NL, PL, SE, UK[67]

[63] approved on case by case basis
[64] To be specifically approved for each plant
[65] in accordance with the regulation on GMOs (genetically modified organisms)
[66] non bio-based source materials max. 5%; conventional plastic polymers are excluded.
[67] Compostable packaging:
Allowed only if independently certified in compliance with one or more of the following:
- BS EN 13432 Packaging - requirements for packaging recoverable through composting and biodegradation.

	Type of waste material	Further specifications	EWC Code	Corresponding EWC waste type	Input materials accepted by MS
1.4.04	Wastes from packaging; absorbents, filter materials, wiping cloths and protective clothing'		15 01 01 15 01 03	paper and cardboard packaging wooden packaging	AT[68], CZ, SI, UK[69]
1.4.05			15 01 09	textile packaging	AT, UK[70]
1.4.06	Municipal Wastes (household waste and similar commercial, industrial and institutional waste) including separately collected fractions'		20 01 01	Paper and cardboard	AT[68], CZ, SI, UK[69]
1.4.07			20 01 99	Other fractions not otherwise specified	SI, UK
1.4.08	Cooking oil and fats, grease trap residues of vegetable origin		02 03 04 20 01 25	Materials unsuitable for consumption or processing Edible oil and fat	AT, [BE][71], CZ, DE, ES, FI, FR, HU, IE, IT, NL, PL, SE, UK[72]
1.4.09	Silage leachate water		02 01 99	Waste not further specified	AT, BE, FR, [IT][56], NL, PL, SE, SI,
1.4.10	Waste from forestry		02 01 07	Waste from forestry	AT, CZ, LU, PL, SI, UK
1.4.11	Fibre rejects	Waste from pulp, paper and cardboard production and processing	03 03 10	Fibre rejects	ES, CZ, PL, SI, UK,
1.4.12	Waste bark and wood	Waste from pulp, paper and cardboard production and processing	03 03 01	Waste bark and wood	ES, CZ, PL, SI, UK
1.4.13	Organic matter from natural products	Wastes from the textile industry	04 02 10	Organic matter from natural products	CZ, ES, UK
1.4.14	Wood	Wastes from construction and demolition wastes	17 02 01	Wood	CZ, SI, UK[73]
1.4.15	Off-specification compost	Only if the compost is derived from input types allowed by this Quality Protocol. This category includes oversize material resulting from screening such compost.	19 05 03	Off-specification compost	CZ, UK
1.4.16	liquor/leachate from a composting process	From vegetable waste treatment only	19 05 99	liquor/leachate from a composting process	CZ, PL, UK
1.5	**Digestion residues from anaerobic digestion of waste materials – pure vegetable origin**				
1.5.01	Digestion residues from the anaerobic treatment of the waste classes 1.1 and 1.2		19 06 06	Digestion residues/-sludge from the anaerobic treatment of animal and vegetable waste	AT, BE, BG, CZ, DE, ES[74], FI, FR, HU, IE, IT, LT, NL, PL, SE, SI, UK
1.5.02	Liquor from anaerobic treatment of municipal waste		19 06 03	Liquor from anaerobic treatment of municipal waste	CZ, ES, SI, UK
1.5.03	Liquor from anaerobic treatment of vegetable waste		19 06 05	Liquor from anaerobic treatment of animal and vegetable waste	CZ, ES, PL, SI, UK
1.5.04	Sludge from cooking fat and oil production, solely vegetable origin	Also centrifugal sludge	02 03 04	Materials unsuitable for consumption or processing (?)	AT, CZ, PL, ES, SI, UK
1.5.05	Glycerine phase	E.g. from rape seed and waste cooking oil esterification (rape seed oil methylester - RME, waste cooking fat methylester)	n.s.	n.s.	AT, SI
1.5.06	Distillation residues from		02 03 04	Materials unsuitable for	AT, CZ, LV, PL, SI, UK

- EN 13432 or EN 14995 in national standard form in any other EU Member State with independent compliance verification by a nationally recognised competent authority or certification body,
- German standard DIN V54900 Testing of the compostability of plastics,
- American standard ASTM D6400 Standard specifications for compostable plastics,
- Any variation upon the standards referred to above for ‚home compostable' packaging agreed between the regulator, WRAP, the Composting Association, the organization is responsible for standards and the certification bodies associated with them.'

[68] Only paper which has been in contact with food and foodstuff (e.g. food packaging)
[69] Not allowed if any non-biodegradable coating or preserving substance is present
[70] Allowed only if entirely natural fibres
[71] Separately collected; in practice not destined for composting
[72] if no chemical agents added and no toxin residues
[73] Not allowed if any non-biodegradable coating or preserving substance is present.
[74] Except for constraints reflected in 1774/2002 regulation

	Type of waste material	Further specifications	EWC Code	Corresponding EWC waste type	Input materials accepted by MS
	production of rape seed oil methyl ester			consumption or processing (?)	
2	**Waste for biological treatment with parts of animal origin**				
2.1	**Animal waste, especially waste from the preparation of foodstuffs**				
2.1.01	Kitchen and food waste from private households with animal residues	Catering waste from source separated organic household waste	20 01 08	Biologically degradable catering waste (To be utilised only if compatible with the provisions of the Animal By-products regulation)	AT, BE[75], CZ, DE, ES, FI, FR, HU, IE, IT, LT, LU, NL, PL[76], SE, SI, UK[77]
2.1.02	Kitchen and food waste from central kitchens and catering services with animal residues		20 01 08	Biologically degradable catering waste (To be utilised only if compatible with the provisions of the Animal By-products regulation)	AT, BE[75], CZ, DE, ES, FI, FR, HU, IE, IT, LT, LU, NL, PL[76], SE, SI, UK[77]
2.1.03	Former foodstuffs of animal origin		020202 020304	Animal tissue waste Materials unsuitable for consumption or processing	AT, BE[75], DE, ES(?), FI, FR, HU, IE, IT[78], LU, LV, PL[76], SE, SI, UK[79]
2.1.04	Eggshells		020202 020304	Animal tissue waste Materials unsuitable for consumption or processing	AT, BE[75], DE, ES, FI, FR, HU, IT[78], LU, PL[76], SE, SI, UK[79]
2.2	**Organic residues from commercial, agricultural and industrial production, processing and marketing of agricultural and forestry products – with parts of animal origin**				
2.2.01	Sludge from the food and fodder industry with parts of animal origin		02 02 03	Materials unsuitable for consumption or processing (?)	AT, BE[75], BG, CZ[78], DE, ES[74], FR, HU, IT[78], NL, PL[76], SE, SI, UK
2.2.02	Press-filter, extraction and oil seed residues from the food and fodder industry with parts of animal origin		02 02 03	Materials unsuitable for consumption or processing (?)	AT, BE[75], CZ[78], DE, ES[74], FR, HU, IT[78], NL, SE, SI, UK
2.2.03	Spoilt feeding stuff of animal origin from fodder producing industry		02 02 03	Materials unsuitable for consumption or processing (?)	AT, BE[75], BG, CZ[78], DE, ES(?), FR, HU, IT[78], NL, PL[76], SE, SI, UK
2.2.04	Residues from horn, hoof, hair, wool, feathers		02 02 02	Animal tissue waste	AT, BE[75], DE, ES[78], FR, HU, IT[78], NL, PL[76], SE, SI, UK
2.2.05	Sludge and press-filter residues from slaughter houses and fattening industries		02 02 02	Animal tissue waste	AT, BE[75], DE, ES[78], FR, HU, IT[78], PL[76], SE, SI, UK[62]
2.2.06	Paunch waste	Belongs to ABPR Cat. 2 Material	02 02 02	Animal tissue waste	AT, BE[75], DE, ES[78], FR, IE, IT[78], NL, PL[76], SE, SI, UK
2.2.07	Solid and liquid manure	Belongs to ABPR Cat. 2 Material	02 01 06	Animal faeces, urine and manure	AT, BE[75], BG, CZ[78], DE, ES(?), FI, FR, HU, IE, IT[78], LU, LV, PL[76], SE, SI, UK[80]
2.2.08	Gelatine waste		02 02 03	Material unsuitable for consumption or processing	AT, BE[75], BG, CZ[78], DE, ES[78], FR, IT[78], PL[76], SE,

[75] Only with individual approval

[76] Organic fertilisers produced using animal wastes by composting or more preferentially biogas method, can get approval but they have to be assessed by veterinary institute.

[77] Only if composted in accordance with national rules at a facility registered by the Animal Health vets

[78] If approved by veterinary service, according to EU regulation on ABP 1774/2002

[79] Only if composted in accordance with 'national rules' requirements at a facility registered by the Animal Health vets.

[80] Slurry and used animal bedding of the following types are allowed; straw, shredded paper; paper pulp; sawdust; wood shavings and chipped wood.

	Type of waste material	Further specifications	EWC Code	Corresponding EWC waste type	Input materials accepted by MS
			02 02 09	Waste not otherwise specified	UK
2.2.09	Wastes from aerobic treatment of solid wastes'	Only allowed if compost was derived from input materials specified in this list	19 05 03	Off-specification compost	CZ[78], SI, UK[80]
2.2.10	Wastes from aerobic treatment of solid wastes'	liquor/leachate from compost processing	19 05 99	Wastes not otherwise specified	SI, UK[81]
2.3	**Digestion residues from anaerobic treatment of waste materials which may contain parts of animal origin**				
2.3.01	Digestion residue of anaerobic digestion of materials of waste **group 2** rendered fat and cooking oil of animal origin		19 06 06	Digestion residues/-sludge from the anaerobic treatment of animal and vegetable waste	AT, BE[75], BG, CZ[78], DE, ES[78], FI, FR, HU, IT[78], PL[76], SE, SI, UK
2.3.02	Digestion residue of anaerobic digestion of dairy residues	e.g. whey, cheese residues and dairy sludge	19 06 06	Digestion residues/-sludge from the anaerobic treatment of animal and vegetable waste	AT, BE[75], BG, CZ[78], DE, ES[78], FI, FR, HU, IE, PL[76], SE, SI, UK
2.3.03	Digestion residue of anaerobic digestion of raw milk	○ Material acc. to Art. 6 (1g) of Regulation 1069/2009/EC	19 06 06	Digestion residues/-sludge from the anaerobic treatment of animal and vegetable waste	AT, BE[75], BG, CZ[78], DE, ES[78], FI, FR, HU, IE, PL[76], SE, SI, UK
2.3.04	Digestion residue of anaerobic digestion of slaughter house waste and by-products		19 06 06	Digestion residues/-sludge from the anaerobic treatment of animal and vegetable waste	AT, BE[75], CZ[78], DE, ES[78], FR, HU, PL[76], SE, SI, UK
2.3.05	Digestion residue of anaerobic digestion of skins, hides and furs		19 06 06	Digestion residues/-sludge from the anaerobic treatment of animal and vegetable waste	AT, BE[75], CZ[78], DE, ES[78], HU, PL[76], SE, SI, UK
2.3.06	Wastes from anaerobic treatment of wastes	Only allowed if compost was derived from input materials specified in this list	19 06 03	Liquor from anaerobic treatment of municipal waste	ES[78], UK
2.3.07	Wastes from anaerobic treatment of wastes		19 06 05	Liquor from anaerobic treatment of animal and vegetable waste	CZ[78], ES[78], UK
2.3.08	Wastes from the preparation and processing of meat, fish and other foods of animal origin		02 02 02	Animal tissue waste	ES[78], PL[76], SI, UK[82]
2.3.09	Wastes from the preparation and processing of meat, fish and other foods of animal origin		02 02 03	Material unsuitable for consumption or processing	CZ[78], ES[78], PL[76], SI, UK[83]
2.3.10	Wastes from the preparation and processing of meat, fish and other foods of animal origin		02 02 09	Wastes not otherwise specified	UK[84]
2.3.11	Wastes from the dairy products industry		02 05 01	Materials unsuitable for consumption or processing	CZ[78], ES[78], PL[76], SI, UK[85]
2.3.12	Wastes from the baking and confectionery industry		02 06 01	Materials unsuitable for consumption or processing	CZ[78], SI, UK[86]
3	**Further waste for biological treatment with *[these wastes might need additional approval of origin and involved processes]***				
3.01	Municipal sewage sludge	Sludge which is used for compost production must be acknowledged for the direct use in agriculture	19 08 05	Sludge from treatment of urban waste water	[AT], BG, CZ, ES[74], FI, FR, HU, IE, IT[87], LT, LU[88], LV, SK, PL, [SE][89], SI, [UK][90]

[81] Liquor/leachate from a process operated according to 'PAS 100 only' or 'PAS 100 and Quality Compost Protocol' requirements (includes restrictions in input material types and sources)..
[82] EWC code 02 02 02 may include animal blood
[83] May include gut contents, shells and shell-fish wastes.
[84] Allowed only if animal manure, slurry or bedding of types which are listed in the UK Quality protocol
[85] May include raw milk.
[86] May consist of, or include former foodstuffs [Category 3 animal by-products],
[87] Sewage sludge is allowed if it complies with Italian enforcement of the European Directive (EC) n° 278/86
[88] Only sewage sludge not mixed with kitchen waste

	Type of waste material	Further specifications	EWC Code	Corresponding EWC waste type	Input materials accepted by MS
3.02	Wastes from the leather and fur industry’		04 01 01	Fleshings and lime split wastes [leather shavings]	CZ, ES, UK
3.03	Municipal solid waste – not source separated				[AT][91], BG, ES, FR, HU, [IE][92], LT, PL, [SE][89], SI,
4	**Additives for composting *[added in minor quantities (up to 10 – 15 % at maximum) in order to improve the composting process, humification and maturation]***				
4.01	Rock dust		01 03 08 01 04 09	Dusty and powdery waste except those belonging to 01 03 07 Waste from sand and clay	AT[93], HU, NL, PL[76], SE?
4.02	Lime stone dust		02 04 02	Calcium carbonate sludge not according to specification	AT[93], BG, DE, FI, FR, HU, LV, NL, SK, PL[76], SE, SI
4.03	Bentonite		---	---	AT[93], DE, HU, PL[76], SE?, SI
4.04	Ash from combustion of plant tissue (e.g. wood, straw)		10 01 01	Bottom ash, slag and boiler dust (excluding boiler dust mentioned in 10 01 04)	AT[94], BG, DE, FI, HU, PL[76], SE?
4.05	Excavated soil	Not contaminated	17 05 04	Soil and stones other than those mentioned in 17 05 03	AT[93 94], HU, SK PL[76], SE? UK[95]
4.06	Washing soil from sugar beet and potato processing		02 04 01	Soil from cleaning and washing beet	AT[93 94], CZ, DE, PL[76], UK[62]

n.s. ... not specified

[89] Not allowed within the QAS Certification scheme of SPRC 152 (compost) and SPCE 120 (digestate); Otherwise this might be used.
[90] BSI PAS 100, but only if HACCP assessment indicates acceptable risk and compost sample test results show sufficient quality → Not allowed under CQP.
[91] Compost from mixed MSW is restricted to the use in reclamation of landfill sites and may only be delivered directly to the landfill.
[92] Not for quality compost. But there are dedicated facilities which process mixed waste which is used in landfills
[93] Sum of all mineral additives for the process optimisation max 10% (m/m); dredged soil: max 15% (m/m)
[94] Limit values for heavy metals must be respected
[95] Allowed only if Hazard Analysis and Critical Control Point (HACCP) assessment determines that adequate pollutant risk control is feasible.

Annex 10: Temperature-time profiles required during the composting process in existing legislation and standards

	Indirect TIME- TEMPERATURE Regime °C	% H_2O	part. size mm	time
ABP Regulation 1069/2009/EC	70		12	1h
EC/ 'eco-label' 2006/799/EC 2007/64/EC				
AT Statutory 'Guidline – State ipf the Art of Composting'	55 – 65 flexible time/temp. regimes are described at min. 55°C 1 to 5 turnings during a 10 – 14 days thermophilic process			10 d
BE VLACO	60 55			4 d 12 d
CZ Biowaste Ordinance	55 65			21 d 5 d
DE Biowaste Ordinance	55 60 1) 65 2)	40 40 40		14 d 7 d 7 d
DK	55			14 d
ES				
FI				
FR	60			4 d
IE Green waste catering waste Cat3 ABP	--- 60 70	---	--- 400 12	--- 2 x 2 d 1 h
IT Fertil. law	55			3 d
LV Cabinet Regulation No. 530 25.06.2006				
NL Beoordelingsrichtlijn Keurcompost	55			4 d
PL				

	Indirect TIME- TEMPERATURE Regime			
	°C	**% H_2O**	**part. size mm**	**time**
SI Decree on the treatment of biodegradable waste (Official Gazette of the Republic of Slovenia, no. 62/08)	55 60 65			14d 7d 7d
UK PAS 100 voluntary standard	65	50		7 d[4]
	min. 2 turnings			

Annex 11: Product property parameters that need to be declared when placing compost on the market (**Proposal from first working document**)

Usefulness concerning soil improving function:

- Organic matter content
- Alkaline effective matter (CaO content)

Usefulness concerning fertilising function:

- Nutrient content (N, P, K, Mg)
- Mineralisable nitrogen content (NH_4-N, NO_3-N)

Biological properties:

- Stability/maturity
- Plant response
- Contents of germinable seeds and plant promulgates

General material properties

- Water or dry matter content
- Bulk density/volume weight
- Grain size
- pH
- Electrical conductivity (salinity)

Hygienic aspects relevant for environmental and health protection

- Presence of salmonellae
- Presence of E.coli

Pollutants and impurities relevant for environmental and health protection

- Contents of macroscopic impurities (such as glass, metals, plastics)
- Contents of Pb, Cd, Cr, Cu, Ni, Hg, Zn

Annex 12: Parameters and limit values of minimum product quality requirements (**Proposal from first working document**)

a) Minimum organic matter content

The minimum organic matter content of the final product, after the composting phase and prior to any mixing with other materials shall be 20%. (This is pretended to prevent dilution of compost with mineral components (e.g. sand, soil).

b) Minimum stability

[propose a requirement?]
A member state has suggested the Oxitop method, alternatively Oxygen Uptake Rate may be measured according to prEN16087-1 or a self heating test may be performed according to prEN 16087-2.

c) Absence of pathogen indicator organism

No salmonella sp. in 50 g sample.

d) Limitation of macroscopic impurities

Total impurities (non biodegradable matter) > 2 mm shall be < 0.5 % (dry matter).

e) Limitation on organic pollutants
Currently there is no proposal for organic pollutants. Denmark holds limit values for 4 persistent organic pollutants: LAS, PAH, NPE and DEHP. France holds limit values for PAH and in the case of compost containing sewage sludge as input material also for PCBs.

f) Limitation of potentially toxic elements (heavy metals)

In the final product, just after the composting phase and prior to any mixing with other materials, the content of the following elements shall be lower than the values shown below, measured in terms of dry weight:

Element	mg/kg (dry weight)	*times the limit in the EU eco-label criteria for soil improvers and growing media (2007/64/EC and 2006/799/EC)*
Zn	400	*4/3*
Cu	100	*1*
Ni	50	*1*
Cd	1.5	*3/2*
Pb	120	*6/5*
Hg	1	*1*
Cr	100	*1*

The limits apply to the compost just after the composting phase and prior to any mixing with other materials.

<u>Rationale for the limit values:</u>

There a number of factors to be considered for finding the most suitable limit values. Some factors are best addressed by very low (i.e. strict) limits, others are reasons for not being too strict. Therefore, a solution is needed that best reconciles the different demands in an acceptable way.

On the one hand, strict limits are needed to meet the following demands:

- There should be no overall adverse environmental or human health impact from the use of end of waste compost
- Environmental impacts in the case of misuse of compost should be within acceptable limits
- The limits should promote the production of higher compost qualities and prevent a relaxation of quality targets (end of waste criteria should not lead to higher contamination levels of composts than today)
- The limits should be an effective barrier to diluting more contaminated wastes with compost
- The limits should exclude compost from end of waste if it cannot be used in a dominant part of the market because it does not meet the existing standards and legislation on use.

On the other hand,

- The benefits of compost use should not be sacrificed because of disproportionate risk aversion
- Limits should not be so strict that they disrupt current best practice of compost production from the biodegradable fractions of municipal solid waste
- Composting as a recycling route for biodegradable wastes should not be blocked by demanding unrealistic and unnecessarily strict limits.

Well-balanced limit values can be found by the following considerations:

1. The limits in the EU eco-label criteria for soil improvers and growing media are the lower bound of what can reasonably be demanded as limits.

The Community eco-label criteria for soil improvers and growing media include limits for hazardous substances. The eco-label criteria were decided by the European Commission in accordance with the corresponding Committee of Member State representatives. They introduced harmonised limit values at Community level.[96]

These limits apply to the growing media constituents in the case of growing media and to the final product in the case of soil improvers. The explicit aim of these eco-label criteria is to promote "the use of renewable materials and/or recycling of organic matter derived from the collection and/or processing of waste material and therefore contributing to a minimization of

[96] Note that the eco-label limit values are valid unless national legislation is more strict. Correspondingly, this paper argues that limits in rules on certain compost uses may be stricter than end of waste criteria if justified.

solid waste at the final disposal (e.g. at landfill)". For soil improvers, the criteria aim at promoting "the reduction of environmental damage or risks from heavy metals and other hazardous compounds due to application of the product." In the case of growing media, the eco-label criteria "are set at levels that promote the labelling of growing media that have a lower environmental impact during the whole life cycle of the product."

The eco-label were established with compost in mind as the prime organic constituent of the eligible growing media and soil improvers and it is apparent that the eco-label criteria have the same aim as the end of waste criteria: to promote the recycling of organic waste while reducing environmental impacts throughout the life cycle and avoiding environmental damage or risks when using the product on land.

The study by ORBIT/ECN (2008) shows that when composts comply with the eco-label limits even continued yearly applications of compost on land would not lead to any unacceptable accumulation of metals in soil within 100 years. This underlines that the eco-label criteria are sufficiently strict to protect the environment.

It also needs to be considered that it would make European legislation inconsistent if end of waste limits were stricter than the eco-label limits. This would lead to paradoxical cases where composts labelled as soil improver with the EU flower-label could not cease to be waste.

It can be concluded that the eco-label criteria are sufficiently strict also as end of waste criteria.

2. The eco-label limits would exclude a considerable part of current and potential compost production from the source segregated biodegradable fractions of household, garden and park waste.

End of waste criteria should not disrupt the successful existing national approaches to composting. Limits for hazardous substances should be oriented at the compost qualities that have proven feasible (can be reliably produced) in the existing best practice compost systems. Best practice currently includes compost production with reliable quality assurance systems and the use of source-segregated biodegradable wastes as input materials.

A study for UBA (Reinhold, 2008) made a statistical evaluation of the compost quality achieved by composting plants that participate in the German quality assurance and certification scheme (which allows the use of source segregated input materials only). From the study it can be shown that with current testing practice about 60 composting plants would not be able to warrant compliance with limits for Zn. For each Pb and Cd there are 36 plants that would not be able to guarantee compliance, and for Cu 18[97]. For Ni, Hg and Cr almost all plants would comply. See also Table 10.

Table 10: Possibility to guarantee compliance with individual limit vales of German composting plants participating in the German compost quality assurance scheme. Compiled from Reinhold (2008) Anlage 5.

	Eco-label limits [g/kg	% of 367 composting plants

[97] It should be noted that by increasing the precision of the testing (more samples) further plants would be in a position to demonstrate compliance. This would come however at higher testing costs.

	(dry weight)]	that can warrant concentrations below the limit at a 95% level of confidence
Cu	100	95.2
Zn	300	83.5
Pb	100	90.2
Cd	1	90.2
Ni	50	98.2
Hg	1	99.7
Cr	100	100

The study by ORBIT / ECN shows that other countries with advanced source separation and composting systems (BE-Flanders, NL, AT) show a very similar level and distribution of heavy metals in both biowaste compost and green waste compost as DE. In Italy and the UK, concentrations of metals in composts from biowaste and green waste compost are comparatively higher (approximately by a factor two higher for most of the metals in the case of Italy, and for Pb in biowaste compost in the case of UK)

For compost producers in 'newcomer' countries it is expected to be very hard to meet limits with the ambition of the ecolabel criteria in the early phase of setting up suitable waste collection systems. A certain relaxation of the most critical limits (Zn, Pb, Cd) would open the door to newcomers by allowing them to have a more realistic perspective of being able to meet end of waste criteria.

One also has to keep in mind that the eco-label is a voluntary instrument that is intended to be selective. Article 4-2.(c) of the eco-label Regulation[98] sets out that "the selectivity of the criteria shall be determined with a view to achieving the maximum potential for environmental improvement." End of waste criteria also aim at an environmental improvement, but not necessarily for a maximum potential because also other aspects of waste management, such as economic cost need to be taken into account.

There are therefore good reasons for end of waste criteria to include higher limits for the most critical elements than the EU eco-label criteria.

3. It is possible to meet the conditions of end of waste criteria even if the critical metal concentration limits are increased to a certain extent compared to the eco-label criteria

ORBIT/ECN (2008) estimates that even with metal concentrations corresponding to the limits of the relatively tolerant French NFU 44051 standard and continued yearly compost applications to soil, critical soil threshold values of the German Soil Protection Ordinance would not be exceeded within more than 50 years in the case of Zn and more than 100 years in the cases of Pb and Cd. The limits of that standard at least triple the eco-label limits for Zn, Pb, Cd. Also misuse by applying to soil higher amounts than phosphate limited application rates are unlikely to lead to critical impacts unless extremely high amounts or repeated over prolonged periods (several years).

However, applying the limits of the NFU 44051 standard would relax the quality targets that are currently used in most places where compost is being produced in significant amounts.

[98] EC 1980(2000)

Furthermore, agricultural use, as main outlet for compost, would not be allowed by current use rules in most of the main compost using countries.

Table 11 gives an overview of the proposed heavy metal limits, compared to compost limits in the Member States for compost aimed at normal agricultural applications. The table also includes the EU Eco-label limits and the EU regulation on organic agriculture.

Table 11: Heavy metal limits for compost aimed at use in agriculture compared to proposed limit values from the IPTS (2008) study, all values in mg/kg (dry weight). Red color shading indicates that a MS has a stricter limit than the proposal, green shading indicates equal or less strict limits.

Country	Regulation	Type of standard	Cd (mg/kg d.m.)	Crtot	CrVI	Cu	Hg	Ni	Pb	Zn	As
AT	Compost Ord.:Class A (agriculture; hobby gardening)	Ordinance	1	70	-	150	0.7	60	120	500	-
BE	Royal Decree, 07.01.1998	Statutory decree	1.5	70	-	90	1	20	120	300	-
BG	No regulation	-	-	-	-	-	-	-	-	-	-
CY	No regulation	-	-	-	-	-	-	-	-	-	-
CZ	Use for agricultural land (Group one)	Statutory	2	100	-	100	1	50	100	300	10
DE	Quality assurance RAL GZ - compost / digestate products	Voluntary QAS	1.5	100	-	100	1	50	150	400	-
DK	Statutory Order Nr.1650; Compost after 13 Dec. 2006	Statutory decree	0.8	-	-	1000	0.8	30	120	4000	25
EE	Env. Ministry Re. (2002.30.12; m° 87) Sludge regulation	Statutory	-	1000	-	1000	16	300	750	2500	-
ES	Real decree 824/2005 on fertilisers Class B	Statutory	2	250	0	300	1.5	90	150	500	-
FI	Fertiliser Regulation (12/07)	Statutory decree	1.5	300	-	600	1	100	150	1500	25
FR	NFU 44 051	standard	3	120		300	2	60	180	600	-
GR	KYA 114218, Hellenic Government Gazette, 1016/B/17- 11-97 [Specifications framework and general programmes for solid waste management]	Statutory decree	10	510	10	500	5	200	500	2000	15
HU	Statutory rule 36/2006 (V.18)	Statutory	2	100	-	100	1	50	100	--	10
IE	(Compost – Class I)	Statutory	0.7	100	-	100	0.5	50	100	200	-
IT	Law on fertilisers (L 748/84; and: 03/98 and 217/06) for BWC/GC/SSC	Statutory decree	1.5	-	0.5	230	1.5	100	140	500	-
LT	Regulation on sewage sludge Categ. I (LAND 20/2005)	Statutory	1.5	140		75	1	50	140	300	-
LU	Licensing for plants		1.5	100	-	100	1	50	150	400	-
LV	Regulation on licensing of waste treatment plants (n° 413/23.5.2006) – no specific compost regulation	Statutory	3	-		600	2	100	150	1500	50
NL	Amended National Fertiliser Act from 2008	Statutory	1	50		90	0.3	20	100	290	15
PL	Organic fertilisers	Statutory	3	100		400	2	30	100	1500	-
PT	Standard for compost is in preparation	-	-	-	-	-	-	-	-	-	-
SE	SPCR 152 Guideline values	Voluntary	1	100	-	600	1	50	100	800	-
SI	Decree on the treatment of biodegradable waste (Official Gazette of the Republic of Slovenia, no. 62/08)	Statutory	0.7	80	-	100	0.5	50	80	200	-
SK	Industrial Standard STN 46 5735 Cl. 1	Voluntary	2	100		100	1	50	100	300	10
UK	Standard: PAS 100	Voluntary	1.5	100	-	200	1	50	200	400	-
EU ECO Label	COM Decision (EC) n° 64/2007 eco-label to growing media; COM Decision (EC) n° 799/2006 eco-label to soil improvers	Voluntary	1	100	-	100	1	50	100	300	10
EU Regulation on organic agriculture	EC Reg. n° 2092/91. Compliacne with limits required for compost from source separated biowaste only	Statutory	0.7	70	-	70	0.4	25	45	200	-
Proposed limit values (IPTS, 2008)			1.5	100		100	1	50	120	400	

With the current proposal, 12 out of the 25 listed Member States have stricter limits for at least one element whereas 13 Member States have equal or less strict limits for all elements. The proposed values could thus be seen as ambitious but realistic to achieve for compost producers in countries with new or emerging compost markets.

For the other elements (Cu, Ni, Hg, Cr) an increase compared to the eco-label limits is not needed because most composting plants following best practice are able to meet the eco-label limits.

Annex 13: Sampling and testing methods

Until horizontal standards elaborated under the guidance of CEN Task Force 151 become available, testing and sampling shall be carried out in accordance with test methods developed by Technical committee CEN 223 'Soil improvers and growing media'[99].

Other test methods may be used if their equivalence is accepted by National Member states. For instance, if other consolidated and approved test methods for soil improvers and fertilisers are used in Member States or third countries, they may substitute some of those set by CEN. Where required testing is not covered by CEN standards or CEN standards in progress of approval, other test methods are pointed out in the annex. These methods are indicative by nature and, as stated above, may be substituted by other methods in use.

Analysis should be carried out by reliable laboratories that are preferably accredited for the performance of the required tests in an acknowledged quality assurance scheme

Terms and definitions

The glossary is regarded to be useful for a uniform comprehension and in order to keep univocal interpretation on test methods.

"Alkaline effective matter": calcium and magnesium in basifying form (e.g. as oxide, hydroxide and carbonate)

"Bulk density": ratio of the dry mass and volume of the sample in grams per litre measured under standard suction conditions (suction pressure: 10 cm); it is sometimes referred to as "apparent density".

"Dry matter**:** the portion of substance that is not comprised of water. The dry matter content (%) is equal to 100 % minus the moisture content %.

"Electrical conductivity": measure of a solution's capacity to carry an electrical current; it varies both with the number and type of ions contained in the solution; it is an indirect measure of salinity.

"Heavy metals": elements whose specific gravity is approximately 5 or higher. They include lead, copper, cadmium, zinc, mercury, nickel, chromium.

"Impurities": physical impurities are defined as all non-biodegradable materials (glass, metals, plastics) with a size > 2 mm.

"Maturity": Maturity (see also "stability") can be defined as the point at which the end product is stable and the process of rapid degradation is finished, or, a biodegraded product that can be used in horticultural situations without any adverse effects. The term maturity can also be interpreted in a wide sense, and also includes the term stability. An attempt to define maturity could be that it is a measure of the compost's readiness for use that is related to the composting process. This readiness depends upon several factors, e.g. high

[99] contact: http://www.cenorm.be/cenorm/index.htm

degree of decomposition, low levels of phototoxic compounds like ammonia and volatile organic acids.

"Moisture content": the liquid fraction (%) that evaporates at 103 ± 2°C (EN 13040).

"Organic matter" (OM): The carbon fraction of a sample of compost which is free from water and inorganic substances, clarified in EN 12829 (HORIZONTAL WI CSS99023) as "loss on ignition" at 550 ± 10 °C.

"Plant response": (Pre-normative Work item of CEN/TC 223 for soil improvers and growing media)

"Stability/stabilisation"**:** refers to a stage in the decomposition of organic matter during composting. The stability is measured as residual biological activity like the Oxygen uptake rate (Prenormative Work item of CEN/TC 223 for soil improvers and growing media), Self-heating test (DIN V 11539; Prenormative work item of CEN/TC 223 for compost). Material that is not stable, but still putrescent, gives rise to nuisance odours and may contain organic phytotoxins.

"Test method's: Analytical methods approved by Member States, institutions, standardising bodies (CEN, UNI, DIN, BSI, AFNOR, OENORM etc.) or by reliable manufacturers' associations (BGK in Germany, TCA in UK, etc.).

"Weed seeds": all viable seeds (and propagules) of undesired plant species found in end products.

Testing parameters	Methods (e.g. EN, etc.)	Short description	EU-Project HORIZONTAL Draft Standards BT/TF 151 & CEN TC400
General material properties			
pH value	EN 13037	A sample is extracted with water at 22°C + 3.0°C in an extraction ratio of 1+5 (V/V). The pH of the suspension is measured using a pH meter.	prEN 15933 Extraction with $CaCl_2$
Electrical conductivity	EN 13038	A sample is extracted with water at 22°C + 3.0°C in an extraction ratio of 1+5 (V/V). The specific electrical conductivity of the extract is measured and the result is adjusted to a measurement temperature of 25°C.	prEN 15937
Water content	EN 13040	Dry the sample (50g) at 103 + 2°C in an oven and cool in the desiccator.	prEN 15934
Dry matter content	EN 13040-	Dry the sample (50g) at 103 + 2°C in an oven and cool in the desiccator.	prEN 15934
Organic matter content (Loss on ignition)	EN 13039/ EN 12829	The test portion is dried at 103°C, than ashed at 450°C/550°C. The residue on ignition (loss on ignition) is a functional dimension for the organic matter content in composts.	prEN 15935 Determination at 550 °C
Alkaline effective matter (CaO content)	BGK 2006[100] BGBl 1992[101] Teil 1 S. 912 VDLUFA , 1995[102]	The method is based on the detemination of basifying substances in fertilisers and sludges. The method is applicable on treated biowaste like compost containing calcium and magnesium in basifying form (e.g. as oxide, hydroxide and carbonate). The substance shall be rendered soluble with acid and the excess of acid back-titrated. The basifying substances shall be specified as % CaO.	no
Particle size distribution	EN 15428	The standard describes a method to determine the particle size distribution in growing media and soil improver by sieving (Sieve size: 31.5 mm, 16 mm, 8 mm, 4 mm, 2 mm, 1 mm).	no
Nutrients			
N (total) (Kjeldahl N)	EN 13654-1	The moisture sample is extracted with a sulphuric acid, is distilled in boric acid. To titrate the ammonia with sulphuric acid 0.1 N.	prEN 16168 prEN 16169

[100] BGK, 2006:Methodenbuch zur Analyse organischer Düngmittel, Bodenverbesserungsmittel und Kultursubstrate, ISBN 3-939790-00-1
[101] Federal Law Gazette BGBl, I p. 912, 1992: Sewage Sludge Ordinance (AbfklärV).
[102] VDLUFA, 1995: Methodenbuch Band II. Die Untersuchung von Düngemitteln, Kap. 6.3 Bestimmung der Basisch wirksamen Bestandteile in Kalkdüngemitteln, 4. Auflage, VDLUFA-Verlag.Darmstadt

Testing parameters	Methods (e.g. EN, etc.)	Short description	EU-Project HORIZONTAL Draft Standards BT/TF 151 & CEN TC400
P (total)	EN 13650	The sample is finely ground and extracted with a hydrochloric/nitric acid mixture by standing for 12 hours at room temperature, followed by boiling under reflux for two hours, the extract is clarified and extracted element determined by ICP.	prEN 16174 prEN 16170 prEN 16171
K (total)	EN 13650	Idem	prEN 16174 prEN 16170 prEN 16171
Mg (total)	EN 13650	Idem	prEN 16174 prEN 16170 prEN 16171
$N0_3$-N (dissolved)	EN 13651	The moisture sample is extracted with 0.0125 $CaCl_2$, ration 1:10. The extract is clarified and analysed by spectrophotometric method.	WI CSS99019 Extraction with 1mol/l potassium chloride, ratio 1:20
NH_4-N (dissolved)	EN 13651 DIN 38405 E5	The moisture sample is extracted with 0.0125 $CaCl_2$, ration 1:10. The extract is clarified and analysed by spectrophotometric method.	WI CSS99019 Extraction with 1mol/l potassium chloride, ratio 1:20
1.2 Biological parameters			
Stability	CEN/TC 223 prWI Aerobic Biological Activity	This parameter refers to a stage in the decomposition of organic matter during composting. The stability is measured as residual biological activity like the Oxygen uptake rate (Prenormative Work item of CEN/TC 223 for soil improvers and growing media), Self-heating test (DIN V 11539; Prenormative work item of CEN/TC 223 for compost). Material that is not stable, but still putrescent, gives rise to nuisance odours and may contain organic phytotoxins.	no
	Part I Oxygen uptake rate	This pre-standard describes a method for determination of the determination of Aerobic biological activity by measuring the oxygen uptake rate (OUR). The method may be applied to growing media and growing media constituents. The oxygen uptake rate is an indicator of the extent to which biodegradable organic substance has been broken down.	no

Testing parameters	Methods (e.g. EN, etc.)	Short description	EU-Project HORIZONTAL Draft Standards BT/TF 151 & CEN TC400
	Part II Self-heating	This pre-standard describes a method for determination of the degree of decomposition in a self-heating test. The method is applicable to biodegradable materials and composts. The degree of decomposition of the test materials is an indicator of the extent to which highly biodegradable organic substances has been broken down. It is used to distinguish between compost types (fresh, mature and substrate compost).	no
Viable seeds and reproductive parts of plants		This standard specifies a test procedures for the assessment of contamination by viable plant seeds and propagules on soil, treated biowaste and sludge. Test sample material is filled into seed trays. The trays are kept at temperature suitable for plant germination for 21 days. The germinated plants have to be counted.	WI CSS99048
Plant response	CEN/TC 223 prWI plant response	This pre-standard specifies procedure to test the plant response on the following materials used as growing media, growing media constituents or soil improvers: Compost, peat, wood fibres, rice hulls, coir, cocoa hulls, clay, clay minerals, expanded clay, perlite, vermiculite, rock wool, sand, pumice, lava, bark and readily mixed growing media. To test the plant response directly using the test material, the test sample is filled into plant containers. Seeds of the respective species are evenly distributed on the surface of the test material. For Chinese cabbage, 15 seeds, for barley, 20 seeds per container have to be used. Then, the plots. are kept at a temperature suitable for plant germination. The plant response of the material can be evaluated by the germination rate and growth of the plants.	no
1.3 Physical contaminants			
Impurities	BGK 2006[6]	Determination of impurities and stones. This standard describes a method to determine the physical impurities > 2 mm and stones > 5 mm in soils, sludges and treated biowastes. The test material is dry sieved and the fractions of stones > 5 mm and differentiated impurities > 2 mm are determined by weight or, for plastics, by weight and area.	WI CSS99049
1.4 Chemical contaminants – Heavy metals			
Pb	EN 13650	The dried sample is finely ground and extracted with a hydrochloric/nitric acid mixture by standing for 12 hours at room temperature, followed by boiling under reflux for two hours, the extract is clarified and extracted element determined by ICP.	prEN 16174 prEN 16170 prEN 16171

[6] BGK, 2006:Methodenbuch zur Analyse organischer Düngmittel, Bodenverbesserungsmittel und Kultursubstrate, ISBN 3-939790-00-1

Testing parameters	Methods (e.g. EN, etc.)	Short description	EU-Project HORIZONTAL Draft Standards BT/TF 151 & CEN TC400
Cd	EN 13650	Idem	prEN 16174 prEN 16170 prEN 16171
Cr	EN 13650	Idem	prEN 16174 prEN 16170 prEN 16171
Cu	EN 13650	Idem	prEN 16174 prEN 16170 prEN 16171
Ni	EN 13650	Idem	prEN 16174 prEN 16170 prEN 16171
Hg	EN 13650	Idem	prEN 16174 prEN 16170 prEN 16171
Zn	EN 13650	Idem	prEN 16174 prEN 16170 prEN 16171
1.5 Hygienic aspects			
Salmonellae	CEN/TC 308 WI (prEN 15215-1, prEN 15215-2, prEN 15215-3)	The Salmonella procedure in sludges, soils and treated biowastes comprises three methods (prEN 15215-1, prEN 15215-2, prEN 15215-3). The absence of Salmonellae in treated biowaste is an indicator that the process requirements in respect to hygienic aspects are fulfilled and that the material is sanitized.	still under validation, deadline of validation phase 30.11.2007
1.6 Sampling			
Sampling	EN 12079	Soil Improver and growing media – Sampling	This has been elaborated by CEN TC 223

Testing parameters	Methods (e.g. EN, etc.)	Short description	EU-Project HORIZONTAL Draft Standards BT/TF 151 & CEN TC400
Framework on sampling		Framework for the preparation and application of a sampling plan: This standard specifies the procedural steps to be taken in the preparation and application of the sampling plan. The sampling plan describes the method of collection of the laboratory sample necessary for meeting the objective of the testing programme.	CSS99031
Selection and application of criteria for sampling		Sampling Part 1: Guidance on selection and application of criteria for sampling under various conditions	CSS99058
Sampling techniques		Sampling Part 2: Guidance on sampling techniques	CSS99057
Sub-sampling in the field		Sampling Part 3 Guidance on sub-sampling in the field	CSS99032
Sample packaging, storage etc.		Sampling Part 4: Guidance on procedures for sample packaging, storage, preservation, transport and delivery	CSS99059
Sampling plan		Sampling Part 5: Guidance on the process of defining the sampling plan	CSS99060
Sample pre-treatment		Guidance for sample pre-treatment	CSS99034

The reports include the following documents:
PART 1. Sampling of sewage sludge, treated biowastes and soils in the landscape - Framework for the preparation and application of a Sampling plan
PART 2. Report on sampling draft standards
Sampling of sludges and treated bio-wastes.

A. Technical Report on Sampling – Guidance on selection and application of criteria for sampling under various conditions.
B. Technical Report on Sampling – Guidance on sub-sampling in the field.
C. Technical Report on sampling – Guidance on procedures for sample packaging, storage, preservation, transport and delivery.

Sampling of sewage sludge and treated biowastes - Guidance on sampling techniques 30-3-2006
Sampling of sewage sludge and treated biowastes - Definition of the sampling plan 27-4-2006

Annex A: Test parameters, upper limit values and declaration parameters for validation for UK PAS 110: 2010 Specification for whole digestate, separated liquor and separated fibre derived from the anaerobic digestion of source-segregated biodegradable materials (Source: http://www.wrap.org.uk/farming_growing_and_landscaping/producing_quality_compost_and_digestate/bsi_pas_110_.html)

Parameter	Method of test	Upper limit and unit
Pathogens (human and animal indicator species) in WD / SL / SF		
ABP digestate: human and animal pathogen indicator species	As per appropriate ABP regulation or any other method approved by the competent authority / Animal Health vet / Veterinary Service vet	As specified by the competent authority / Animal Health vet / Veterinary Service vet in the 'approval in principal' or 'full approval'
Non-ABP digestate: *E. coli*	SCA MSS Part 3A or BS ISO 16649-2	1000 CFU / g fresh matter
Non-ABP digestate: *Salmonella* spp	Method as specified by appropriate ABP regulation, according to nation in which digested material is produced, or SCA MSS Part 4A	Absent in 25 g fresh matter
Potentially Toxic Elements in WD / SL / SF. If necessary, WD and SL may utilize the exemption provisions in clauses 13.2, 14.1.6 and 14.1.7 with the declarations required under the * provision below in this table		
Cadmium (Cd)	BS EN 13650 (soluble in aqua regia)	1.5 mg / kg dry matter
Chromium (Cr)	BS EN 13650 (soluble in aqua regia)	100 mg / kg dry matter
Copper (Cu)	BS EN 13650 (soluble in aqua regia)	200 mg / kg dry matter
Lead (Pb)	BS EN 13650 (soluble in aqua regia)	200 mg / kg dry matter
Mercury (Hg)	BS ISO 16772	1.0 mg / kg dry matter
Nickel (Ni)	BS EN 13650 (soluble in aqua regia)	50 mg / kg dry matter
Zinc (Zn)	BS EN 13650 (soluble in aqua regia)	400 mg / kg dry matter
Stability of WD / SL / SF		
Volatile Fatty Acids	Gas chromatography (example provided in OFW004-005)	Screening value: 0.43 g COD / g VS
Residual Biogas Potential	OFW004-005 (WRAP)	0.25 l / g VS
Physical contaminants in WD / SL / SF		
Total glass, metal, plastic and any 'other' non-stone, man-made fragments > 2 mm	REA-DM-PC&S	0.5 % m/m dry matter, of which none are 'sharps' (see 3.72)
Stones > 5 mm	REA-DM-PC&S	8 % m/m dry matter

NOTE Separated liquor is exempt from physical contaminants tests only if the separation technology used by the producer results in all particles < 2 mm in the separated liquor fraction.

Parameter	Method of test	Declaration and unit
Characteristics of WD / SL / SF for declaration, without limit values, that influence application rates		
pH	BS EN 13037	Declare result as part of typical or actual characteristics
Total nitrogen (N)	BS EN 13654-1 (Kjeldahl) or BS EN 13654-2 (Dumas)	Declare result as part of typical or actual characteristics, units as appropriate (e.g. kg m^{-3} fresh matter and nutrient units per 1000 gallons fresh matter)
Total phosphorus (P)	BS EN 13650 (soluble in aqua regia)	
Total potassium (K)	BS EN 13650 (soluble in aqua regia)	
Ammoniacal nitrogen (NH_4-N) extractable in potassium chloride	SOP Z/004 (soluble in potassium chloride)	
Water soluble chloride (Cl^-)	BS EN 13652 (soluble in water)	
Water soluble sodium (Na)	BS EN 13652 (soluble in water)	
Dry matter (also referred to as total solids)	BS EN 14346	Declare result as part of typical or actual characteristics, % m/m of fresh sample
Loss on ignition (also referred to as volatile solids and a measure of organic matter)	BS EN 15169	Declare result as part of typical or actual characteristics, units as appropriate
* Characteristics of WD / SL for declaration when PTE limit values are exceeded, that influence application rates (see 13.2, 14.1.6 and 14.1.7)		
Potentially toxic elements (Cd, Cr, Cu, Pb, Hg, Ni, Zn) in whole digestate or separated liquor if the digested material type exceeds any PTE limit in this table	As specified above in this table for the appropriate PTE	If any PTE limit in this table is exceeded in whole digestate or separated liquor, declare results for all PTEs in the digested material type, either as actual results for the sampled portion of production or as part of typical characteristics (see 13.2), in mg / kg dry matter

NOTE 1 If a digestate sample's VFA result exceeds the VFA 'screening value' above, this will be assumed indicative of the sample failing the RBP test. In such circumstance, the RBP test is not required to be carried out and the sample has failed the digestate 'stability' test. Assessment of RBP test pass or fail should use the average of the triplicate RBP values that each sample test generates.

NOTE 2 PAS 110 does not require testing and declaration of digested material particle size. If such information is desired, the maximum particle size and the > 2 mm particle size distribution of digested material can be tested according to the method 'Kapitel II. A 3.1, 1. Lfg. 9/2006, BGK' [25].

NOTE 3 PAS 110 does not require testing and declaration of all water soluble nutrients and elements. If further nutrient and element information is desired, digested material can be tested according to the method in BS EN 13652 (see Clause 2).

Annex B: Sweden SPCR 120 QAS for digestate: requirements for final product (Source: http://www.avfallsverige.se/fileadmin/uploads/Rapporter/Biologisk/B2009b.pdf)

Metals

Guideline values for metal content in digestate are set out in Table 1.

Table 1. Guideline values for metal content in compost.

METAL	MAXIMUM CONTENT, mg/kg TS[1])
Lead	100
Cadmium	1
Copper	600[2)]
Chromium	100
Mercury	1
Nickel	50
Zinc	800[2)]

1) All values, aside from those of copper and zinc, are conforming to the guideline values for soil impro vers according to the "EU flower".

2) The values applied to copper and zinc are the same as for waste water sludge allowed for dispersion on fields, see SNFS 1998:4.

Disease control

The product must meet the requirements for disease control specified in Appendix 3.

Visible impurities

'Visible impurities' means foreign substances such as plastic, glass, metals and composites. The total content of visible impurities >2 mm must not exceed 0.5 % of the dry substance weight.

If the input material is of a kind that has a low probability for visible impurities, the certifying authority can give approval of dispensation from this requirement.

Requirements for solid digestate

- **Viable weed seeds and plant parts** – requirements for approval are that the product contains less than 2 viable weed seeds or plant parts per liter.
- **Organic substance** – The product must contain at least 20 % of organic substance, measured as loss on ignition in percent of the dry substance weight.

Annex C: Quality criteria for digestate products from biowaste according to German RAL GZ 245 quality assurance scheme (Source: http://www.kompost.de/uploads/media/Quality_Requirements_of_digestion_residuals_in_Germany_text_02.pdf)

Quality criteria	**Quality requirements**
Hygienic aspects	- Proof for successful treatment for sanitization (heating of the input material to 70 °C for at least 1 hour or input-output control) - Proof of compliance with the hygienic requirements by temperature profiles (monitoring the process temperature) - Maximum of 2 germinable weeds and sprouting plant parts per liter - Salmonella not traceable
Impurities	- Maximum 0,5 M.-% dm selection and weighing of impurities (glass, plastics and metals > 2 mm - With an impurity content > 0,1 M.-% dm: maximum area sum of the selected impurities shall not exceed 25 cm^2/l fm
Degree of fermentation	- Organic acids (total) ≤ 4.000 mg/l
Odour	- Free from annoying odours
Organic Matter	- Minimum 30 M.-% dm, determined by loss on ignition
Heavy metal content (Pb, Cd, Cr, Cu, Ni, Hg, Zn)	- Limit values correspond to the waste and fertiliser legislation - For micro-nutrients Cu and Zn plausible value should not be exceed.
Parameter for declaration	- Product type (digestate product liquid or solid) - Name of producer - Bulk density (volume weight) - Dry matter content - pH-value - Salt content - Plant nutrients (total) (N, P_2O_5, K_2O, MgO, S) - Nitrogen soluble (NH_4-N; NO_3-N) - Micro-nutrients (according to fertiliser legislation) - Organic matter - Alkaline effective matter (CaO) - Benefit value index - Weight or volume - References for good practical use

Annex C2: Quality assurance system for digestate in Flanders (Belgium) by VLACO

The quality assurance system is obligatory for all professional composting and digestion plants in Flanders (Belgium). The QAS is based on the principles of integral chain management. The QAS takes into account all aspects of the processing chain, from the acceptance of biowaste, the quality of the treatment process, end product quality up to customer support for a reasoned use. The outcome of the QAS on treatment plant level is one or several product certificates, showing that the compost, digestate or biothermically dried fertiliser, is produced according to the criteria set up in the certification scheme and the waste legislation. Without the control certificate, treated biowaste cannot be used as a secondary material. Control of compliance with this certification scheme is done through means of regular audits and product sampling.
The most important aspects of the VLACO quality assurance system are:

(a) a strict acceptance protocol
(b) process management according to ISO-principles
(c) quality monitoring of the end product
(d) reasoned use of the end products

(a) a strict acceptance protocol

Treatment plants must have procedures describing the acceptance of inputs. Only separately collected biowaste is allowed to be used as an input. Regular sorting analyses must be carried out. Through visual control at the gate and regular sorting tests of the biowaste being presented, treatment plants ensure an input stream of continuous high quality. In case of non-conformity with the acceptance criteria, the biowaste is refused, and the cause of incompliance has to be dealt with. The quality of separately collected biowaste from households, if insufficient, can be adequately improved through information campaigns. The acceptance of a fraction of industrial biowaste from food industries is only possible when regular analyses on agricultural and environmental parameters are carried out.
For digestion plants, the control of the input registers is an important part of the audit. It is explicitly verified whether the various input streams meet VLAREA policies and whether principles in the Waste policies are imposed, including non-dilution principle, registration and traceability,
This requires an understanding of the composition of all input streams. Where digesters accept mixtures processed by an external supplier delivered as a blend, there is in practice no traceability to the individual streams. This information is often not provided by the supplier of the mix, for practical and commercial reasons. Therefore, VLACO has developed a separate quality assurance system for this mix, to be independently monitored (through sampling and analysis) and attested, ensuring that the use of organic-biological waste mixes meets the quality requirements of the digestion plants.

(b) process management according to ISO-principles

VLACO has set up a QAS for professional treatment plants of biowaste according to the principles of the ISO 9000 certification standard and integral chain management. The whole chain of biowaste treatment, from input quality over the treatment process and quality assessment of the end products is monitored using an integral quality management system, set in place on every treatment plant. Experience showed that a quality assessment only based on end product testing is insufficient. Non-conformities are reported and countered with adequate measures ensuring a progressive improvement of the quality of the production. Registration of the key aspects (dates, batch numbers, type and quality of input material, process parameters e.g. temperature, management actions e.g. …) leads to an auto control system that allows tracking and tracing of the products. During the important step of hygienisation of the biowaste, temperature and management are to be checked very carefully. Moreover, other legislation on regional, federal or European level (e.g. the Animal By-products Regulation 1069/2009, the intended EPPO-guidelines for treatment of biowaste of plant origin) also suggest the importance of a well-founded QAS on treatment plant level together with adequate and sufficient product testing.
The outcome of the system audits together with continued product testing can lead to a control certificate, approving that the products are in accordance with the quality requirements.

(c) quality monitoring of the end product

The VLAREA-legislation for use of treated biowaste as a secondary material (fertiliser or soil improver) sets up limit values for the most important environmental parameters, both organic (PAH, PCB, volatile compounds, …) and inorganic (heavy metals). The VLACO QAS is based on limit values that are even stricter than these values, and carries along parameters indicating the agronomic importance of the end products (nutrients, soil organic matter) as well as the physical and biological quality aspects (impurities, viable seeds, stability). In the tables below the quality standards for digestate are shown. Nutrient composition is tested and to be declared to the user, not regulated.
The necessary samples are taken by VLACO and dispatched for analysis to accredited laboratories using recognised methods. The amount of samples necessary per treatment plant is calculated on the basis of bio-waste input. When several product types are produced at the same location, the sampling and analysis protocol is carried out by VLACO on all product types. The outcome of one analysis is always compared to the product standards, but the decision about certification is based on a progressive set of sample results, with quality objectives that are stricter than the product standards. By reviewing several product analysis results on a continuous time scale, the quality assurance organisation (VLACO) is able to observe temporal product incompliance. This can be related to non-conform process parameters which must be solved in an action plan. Solitary product analysis reports are insufficient sources of information for assessing a compost production plant. Compost or digestate are thought to be not only a product, but the result of a controlled and sustainable biological treatment process of separately collected biowaste.
Besides the analyses carried out by VLACO, the treatment plants are themselves obliged to take product samples for internal quality assurance.

(d) reasoned use of the end products

Not only the composition of the end product is a possible risk from the point of view of environmental or public health matters, also the unreasoned use could pose a problem, e.g. excessive application rates with undesired side effects such as phytotoxicity, nutrient overshoot or imbalance, … Therefore, the VLACO QAS imposes the professional composting plants to inform the consumers about the use of the product(s), in all possible applications. This is done by an information leaflet mentioning the composition, usual application rates, application manner, hygienic safety, …

The integration of quality assurance measures all along the production chain of compost, with strong emphasis on product input, regular product testing and reasoned use of product output, enhances the possibility to assure environmental and public health safety. This is guaranteed through the issuing of control certificates for the different products by VLACO.

The assessment for the granting of control certificates for other types of biological processing (anaerobic digestion and biothermally drying) is similar to the assessment of composting.The control certificate is reflecting the application possibilities of the output streams. Without a certificate the final product can not be applied to Flemish soil (VLAREA) and will not obtain a derogation of the FPS (Federal Public Service), meaning that it can not be traded in Belgium as fertilizer or soil improver. For export outside Flanders, the output product is still considered as waste and as such subject to European waste regulations.

Flanders Vlaco-standards for digestate (agronomic parameters and product standards)

Agronomic parameters:

	VLAREA-standard	Vlaco-standard	Federal standard (raw digestate)	Unity
GENERAL PARAMETERS				
Dry matter	-	-	>4	weight%
Organic matter	-	-	>2	weight%
pH (water)	-	6,5 - 9,5	6,5 - 9,5	-
HEAVY METAL CONCENTRATION				
Arsenic (As)	<150	<150	<150	mg/kg DM

	VLAREA-standard	Vlaco-standard	Federal standard (raw digestate)	Unity
Cadmium (Cd)	<6	<6	<6	mg/kg DM
Chromium (Cr)	<250	<250	<250	mg/kg DM
Copper (Cu)	<375	<375	<375	mg/kg DM
Mercury (Hg)	<5	<5	<5	mg/kg DM
Lead (Pb)	<300	<300	<300	mg/kg DM
Nickel (Ni)	<50	<50	<50	mg/kg DM
Zinc (Zn)	<900	<900	<900	mg/kg DM
IMPURITIES, STONES AND VIABLE SEEDS				
Impurities > 2 mm	-	<0,5	<0,5	weight %
Stones >5 mm	-	<2,0	<2,0	weight %
Viable seeds	-	Max. 1	<1	#/l
STABILITY				
Oxigen consumption (Oxitop®)	-	50	-	mmol O_2/kg OS/h

Product standards (concentrations) for all secondary materials (maximum level of pollutants, VLAREA Annex 4.2.1.A) including digestate:

	Total concentration	Unity
METALS[103,104]		
Arsenic (As)	150	mg/kg DM
Cadmium (Cd)	6	mg/kg DM
Chromium (Cr)	250	mg/kg DM
Copper (Cu)	375	mg/kg DM
Mercury (Hg)	5	mg/kg DM
Lead (Pb)	300	mg/kg DM
Nickel (Ni)	50	mg/kg DM
Zinc (Zn)	900	mg/kg DM
MONOCYCLIC AROMATIC HYDROCARBONS (BETXS) [105]		
	Total concentration	**Unity**
Benzene	1,1	mg/kg DM
Ethylbenzene	1,1	mg/kg DM
Toluene	1,1	mg/kg DM
Xylene	1,1	mg/kg DM
Styrene	1,1	mg/kg DM
POLYCYCLIC AROMATIC HYDROCARBONS (PAH) [3]		
Benzo(a)anthracene	0,68	mg/kg DM
Benzo(a)pyrene	1,1	mg/kg DM
Benzo(g,h,i)perylene	1,1	mg/kg DM
Benzo(b)fluoranthene	2,3	mg/kg DM
Benzo(k)fluoranthene	2,3	mg/kg DM

[103] The concentration counts for the metal and the compounds expressed as the metal

[104] Measurement of the total concentration of metals according to the method CMA 2/II/A.3 from the Compendium for Sampling and Analysis for Waste

[105] Measurement of the total concentration of organic compounds according to the methods in part 3 from the Compendium for Sampling and Analysis for Waste

Chrysene	1,7	mg/kg DM
Phenanthrene	0,9	mg/kg DM
Fluoranthene	2,3	mg/kg DM
Indeno(1,2,3c,d)pyrene	1,1	mg/kg DM
Naphtalene	2,3	mg/kg DM
OTHER ORGANIC POLLUTANTS[3]		
Monochlorobenzene	0,23	mg/kg DM
Dichlorobenzene	0,23	mg/kg DM
Trichlorobenzene	0,23	mg/kg DM
Tetrachlorobenzene	0,23	mg/kg DM
Pentachlorobenzene	0,23	mg/kg DM
Hexachlorobenzene	0,23	mg/kg DM
1,2-dichloroethane	0,23	mg/kg DM
Dichloromethane	0,23	mg/kg DM
Trichloromethane	0,23	mg/kg DM
Trichloroethene	0,23	mg/kg DM
Tetrachloromethane	0,23	mg/kg DM
Tetrachloroethene	0,23	mg/kg DM
Vinyl chloride	0,23	mg/kg DM
1,1,1-trichloroethane	0,23	mg/kg DM
1,1,2-trichloroethane	0,23	mg/kg DM
1,1-dichloroethane	0,23	mg/kg DM
cis+trans-1,2-dichloroethane	0,23	mg/kg DM
Hexane	5,5	mg/kg DM
Heptane	5,5	mg/kg DM
Octane	5,5	mg/kg DM
Extractable Organic Halogens (EOX)	20	mg/kg DM
Mineral oil C10-C20	560	mg/kg DM
Mineral oil C20-C40	5600	mg/kg DM
Polychlorinated biphenyls (PCB as sum of 7 cogeners)	0,8	mg/kg DM

Annex C3: UK Biofertiliser Certification Scheme

This quality assurance scheme is owned by the Renewable Energy Association and has been created for the purpose of certifying AD/biogas plants in England, Wales and Northern Ireland against the requirements of:

- the British Standards Institution's PAS 110:2010, 'Specification for whole digestate, separated liquor and separated fibre derived from the anaerobic digestion of source-segregated biodegradable materials' (see http://www.biofertiliser.org.uk/certification/england-wales/pas110); and
- the 'Quality Protocol for the production and use of quality outputs from the anaerobic digestion of source-separated biodegradable waste' (see http://www.environment-agency.gov.uk/static/documents/Business/AD_Quality_Protocol_GEHO0610BSVD-E-E.pdf). Later in this section this protocol is referred to as the AD QP. This document is a joint Environment Agencies for England, Wales & Northern Ireland, Defra and WAG initiative and defines the point at which digestates cease to be waste and can be used as a product, without the requirement for waste management controls.

In order for digestate to be used as 'product' in Scotland, the AD/biogas plant and its digestate must be certified compliant with PAS 110 (not also the AD QP) with further conditions specified by the Scottish Environment Protection Agency (SEPA).

Specifications for digestate

In the countries of the UK, PAS 110 is currently the only specification for whole digestate, separated liquor and separated fibre derived from the anaerobic digestion of source-segregated biodegradable materials. In summary, PAS 110:

- sets a minimum baseline standard for digestates; some customers may require the digestates to achieve quality characteristics that are more stringent than those in the specification or cover a wider range of parameters. The AD operator is responsible for checking and agreeing with the customer any quality requirements that are more stringent or wider ranging than the minimum baseline specified in this PAS.
- requires that the digestates are only made from source-segregated biodegradable waste;
- specifies controls on input materials and the management system for the process of anaerobic digestion and associated technologies; the management system must include a Hazard Analysis and Critical Control Point Plan;
- sets minimum quality criteria for whole digestate, separated liquor and separated fibre; and
- establishes the information that is required to be supplied to digested material customers.

Minimum quality criteria

The minimum quality criteria for digestates are shown in Table 1, page 31 of the specification (http://www.biofertiliser.org.uk/pdf/PAS-110.pdf). Table 2, page 34, provides minimum quality criteria for digested material made only from manure, unprocessed crops, processed crops, crop residues, glycerol, and/or used animal bedding that arises within the producer's premises or holding. These criteria apply only if the digestate is used entirely within the same premises or holding.

Labelling / declaration requirements
Section 14, page 44 of PAS 110 specifies the information that shall be supplied to each customer. This shall include the typical characteristics or laboratory test results corresponding with the portion of production dispatched, and include:

a) PTE concentrations;
b) pH;
c) total nitrogen;
d) total phosphorus;
e) total potassium;
f) ammoniacal nitrogen (NH4-N);
g) water soluble chloride;
h) water soluble sodium;
i) dry matter (also referred to as total solids); and
j) loss on ignition (also referred to as volatile solids, and a measure of organic matter).

Sampling and analysis of digestate
For validation: See PAS 110, section 11.2, basis of this being 'For each parameter in Table 1, the three most recent digested material sample test results shall not exceed the corresponding upper limit. This applies to each digested material output type for which PAS 110 conformance is claimed (whole digestate, separated fibre and/or separated liquor).'

After validation: see PAS 110, section 12.2, basis of this being 'For each parameter in Table 3, the three most recent digested material sample test results shall not exceed the corresponding upper limit. Samples of digested material shall be tested at least at the minimum frequencies specified in Table 4. This applies to each digested material output type for which PAS 110 conformance is claimed (whole digestate, separated fibre and/or separated liquor).'

PAS 110, Table 4 – Minimum frequencies for testing representative samples of digested material after validation

Parameter	Minimum frequencies for testing representative samples
If ABP digested material: human and animal	As specified by the competent authority / Animal Health pathogen indicator species vet in the 'approval in principal' or 'full approval'
If non ABP digested material: *E. coli*	1 per 5,000 m^3 of WD (whole digestate)/ SF (separated fibre) / SL (separated liquor) produced, or 1 per 3 months whichever is the soonest
If non ABP digested material: *Salmonella* spp	1 per 5,000 m^3 of WD / SF / SL produced, or 1 per 3 months whichever is the soonest
Potentially Toxic Elements	1 per 6,000 m^3 of WD / SF / SL produced, or 1 per 3 months whichever is the soonest
Stability	2 per 12 months and not within 3 months of each other, or (Volatile Fatty Acids and Residual Biogas sooner if and when significant change occurs (see 4.8.5) Potential, subject to Note 1 to Tables 3 and 5)
Physical contaminants	1 per 6,000 m^3 of WD / SF / SL produced, or 1 per 3 months whichever is the soonest
pH	1 per 6,000 m^3 of WD / SF / SL produced, or 1 per 3 months whichever is the soonest

Total N, P & K	1 per 6,000 m^3 of WD / SF / SL produced, or 1 per 3 months whichever is the soonest
Ammoniacal nitrogen, water soluble chloride	1 per 6,000 m^3 of WD / SF / SL produced, or 1 per 3 months, whichever is the soonest
Water soluble sodium	1 per 6,000 m^3 of WD / SF / SL produced, or 1 per 3 months whichever is the soonest
Dry matter (total solids)	1 per 6,000 m^3 of WD / SF / SL produced, or 1 per 3 months whichever is the soonest
Loss on ignition (measure of organic matter)	1 per 6,000 m^3 of WD / SF / SL produced, or 1 per 3 months whichever is the soonest

Annex C4: England, Wales and Northern Ireland 'Quality Protocol for the production and use of quality outputs from the anaerobic digestion of source-separated biodegradable waste' (AD QP).

According to the AD QP, the quality digestate will be classed as a product only if:
a) It has been produced using only those source-segregated input materials listed in Appendix B (positive list of allowed wastes, can be found at page 14 of the AD QP (http://www.environment-agency.gov.uk/static/documents/Business/AD_Quality_Protocol_GEHO0610BSVD-E-E.pdf)
b) meets the requirements of an approved standard (BSI PAS 110:2010); and
c) is destined for appropriate use in one of the designated market sectors.

In addition, the AD operator must obtain certification by an independent certification body, which must be accredited by the United Kingdom Accreditation Service.
Thus, in England, Wales and Northern Ireland, digestates that are certified under the BCS for compliance with the requirements of BSI PAS 110 and the AD QP are regarded as 'product', thus, can be transported, stored, handled and used without the need for waste regulatory controls.

The AD QP requires that records of digestate use are kept by the land manager (the person responsible for the exploitation of the agricultural land concerned directly or through the use of agents or contractors). These records must enable the land manager to demonstrate that the following have been complied with:

a) NVZ rules, Cross Compliance and good agricultural practice have been followed; and
b) The maximum permissible levels for the soil PTE (potentially toxic elements, namely, heavy metals) in the Code of Practice for Agriculture Use of Sewage Sludge (1989) have not been exceeded as result of the digestate applications.

To date Scotland has not adopted the AD QP and compliance with the requirements of BSI PAS 110 only is sufficient to confer the digestate the status of 'product', providing that the conditions specified in the Scottish Environment Protection Agency are satisfied (see SEPA's position statement at http://www.biofertiliser.org.uk/pdf/SEPA-Position-Statement.pdf).

Digestate as 'waste'
In the UK, digestates that are not certified under the Biofertiliser Certification Scheme are classed as 'wastes', thus, must be supplied, and transported according to duty of care requirements, by registered waste carriers.

In addition, uncertified digestates must be used under waste regulatory controls, which means that end users must hold the appropriate authorisation granted by the regulator to spread the digestates (e.g. environmental permit [England, Wales], waste management licence [Scotland, Northern Ireland], or exemption from a waste management licence or environmental permit). Information about the waste regulatory controls that apply to the use of digestates can be found for:

a) England and Wales at http://www.environment-agency.gov.uk/business/topics/permitting/117161.aspx

b) Scotland at http://www.sepa.org.uk/waste/waste_regulation/application_forms/exempt_activities/paragraph_7.aspx
c) Northern Ireland at http://www.doeni.gov.uk/niea/waste-home/authorisation/exemption/wml_complex_exemptions/paragraph_9.htm

Registration/certification systems for digestate

The Biofertiliser Certification Scheme procedures for registration and certification are as follows:
a) When ready to apply for certification, the AD operator selects a Certification Body from the two contracted organisations and requests an application form together with any documentation that is necessary for certification.
b) The AD operator then forwards the full application form plus accompanying documents and fee to the Certifying Body.
c) The application is reviewed by a Certification Officer (CO) to ascertain if the plant system is in line with the requirements of the certification scheme, and if it is, then an appointment to visit the site is made.
d) If however there is still work to be completed, the Certification Officer (CO) notifies the plant of the requirements and when the changes have been made the CO will make a site visit.
e) A site inspection is carried out by a Certification Officer
f) If successful this marks the start of validation
g) If there are corrective actions then these are notified to AD operator The corrective actions taken are then notified to the CO who will decide whether a further site visit is necessary.
h) When the corrective action is accepted successfully, certification is awarded.
More information about the procedures can be found in the BCS Scheme rules (England, Wales and Northern Ireland, downloadable from http://www.biofertiliser.org.uk/pdf/scheme-rules.pdf; Scotland: http://www.biofertiliser.org.uk/pdf/scheme-rules.pdf).

Input material for End of Waste digestate

End of Waste criteria regarding digestate are set in the AD QP (see http://www.environment-agency.gov.uk/static/documents/Business/AD_Quality_Protocol_GEHO0610BSVD-E-E.pdf).

Digestate 'products' must only be produced from:
a) '…non-waste biodegradable materials. These are not listed separately in this Quality Protocol.' (see clause 2.2.2 i) of the AD QP)
b) 'Where a digester operator accepts waste materials, they may accept only those waste types listed in Appendix B and they must be source-segregated, i.e. they must been kept separate from any other wastes and non-biodegradable materials'.

The AD QP's positive list does not include mixed wastes and sewage sludges.

According to PAS 110 input materials shall be source-segregated biowastes and/or source segregated biodegradable materials. Input materials to the digestion system shall not include contaminated wastes, products or materials.

The AD QP’s reference to non-waste biodegradable materials’ and PAS 110’s reference to ‘source segregated biodegradable materials’ allow the inclusion of virgin materials (e.g. energy crops) to the digestion process. These are important provisions for encouraging digestion of suitable biodedradable wastes and materials, and should be particularly valuable where a digestion facility is located near to supply of energy crop(s) and other suitable non-waste materials that are source-segregated and biodegradable.

Animal by-product treatment requirements

According to PAS 110, digested materials shall be produced by an anaerobic digestion process that includes:

a) one of the combinations of pasteurization criteria specified in Table A1; or
b) the specific pasteurization criteria approved by the Competent Authority (Animal Health vet) for digesting ABPs.

Table A.1 of PAS 110 sets out the key provisions in the Animal By-Products Regulations that can be regarded as a pasteurization step, or part of the anaerobic digestion process, within the context of PAS 110.

Table A.1 – Minimum anaerobic digestion requirements specified in the animal by-products regulations

System	National ABP Regulations, option for catering waste only	National ABP Regulations, option for catering waste only	EU ABP regulation 1774/2002 [5a] (See Note 4)
Treatment technology	Closed reactor	Closed reactor	Closed reactor
Maximum particle size	50 mm	60 mm	12 mm
Minimum temperature	57 °C	70 °C	70 °C
Minimum time spent at the minimum temperature	5 hours	1 hour	1 hour
Additional requirements	Followed by storage for an average of 18 days if digestate is made from catering wastes that include meat		No post treatment minimum storage period specified

See also the notes to Table A.1, page 46 of PAS 110 (http://www.biofertiliser.org.uk/pdf/PAS-110.pdf).

Digested materials made only from manure, unprocessed crops, processed crops, crop residues, glycerol, and/or used animal bedding that arise within the producer’s premises or holding and that are used entirely within the same premises or holding are exempt from the pasteurization step. However, the producer shall determine the process steps, the Critical Control Point and its Critical Limits (e.g. minimum timescale and suitable mesophilic temperature range) that are effective for producing digested materials of the quality required in the PAS 110.

Exemption from the pasteurization step is also allowed for manure, unprocessed crops, processed crops, crop residues, glycerol, and/or used animal bedding that arises within the producer's premises or holding, if such input materials are co-digested with pasteurized biodegradable materials / wastes from any source(s) outside the producer's premises or holding. This material source-specific exemption from pasteurization is conditional upon all the digested material being used within the producer's premises or holding.

Requirements for dispatch and use of digestates

According to PAS 110, for each consignment of whole digestate, separated liquor or separated fibre derived in whole or in part from ABP material, which is dispatched for a use other than disposal, the producer shall inform the customer that the product includes or consists of treated ABP material and that the user will have committed an offence if he/she does not comply with ABP Regulation requirements that place restrictions on use and require the user of ABP-digestate to keep records.

The national Animal By-Product Regulations in force in the countries of the UK[106] include controls on the placement of digested materials made from catering or other ABP source-segregated biowastes on the market, livestock grazing ban periods after spreading such materials, records that must be made and kept by the user, and obligations associated with any transfrontier shipment of animal by-products, whether treated or untreated.

Example excerpts from The Animal By-Products (Enforcement) (England) Regulations 2011 (SI 2011, No. 881):
'Use of organic fertilisers and soil improvers, Article 7.
(1) Where organic fertilisers or soil improvers are applied to land, no person may allow pigs to have access to that land or to be fed cut herbage from such land for a period of 60 days beginning with the application of the organic fertiliser or soil improver.
(2) Paragraph (1) does not apply to the following organic fertilisers or soil improvers—
(a) manure;
(b) milk;
(c) milk-based products;
(d) milk-derived products;
(e) colostrum;
(f) colostrum products; or
(g) digestive tract content.'

'Part 4, Offences and Penalties, Article 17.
(1) A person who fails to comply with an animal by-product requirement commits an offence.
(2) "Animal by-product requirement" means any requirement in Column 2 of Schedule 1 to these Regulations as read with the provisions in Column 3 to that Schedule.'

* The national ABP Regulations for England, Wales, Northern Ireland and Scotland can be found here:
England and Wales: http://www.legislation.gov.uk/uksi/2011/881/contents/made
Scotland: http://www.legislation.gov.uk/ssi/2011/171/contents/made
Northern Ireland: http://www.legislation.gov.uk/nisr/2011/124/contents/made

[106] The national ABP Regulations for England, Wales, Northern Ireland and Scotland can be found here:
England and Wales: http://www.legislation.gov.uk/uksi/2011/881/contents/made
Scotland: http://www.legislation.gov.uk/ssi/2011/171/contents/made
Northern Ireland: http://www.legislation.gov.uk/nisr/2011/124/contents/made

Legislation on digestate use under waste status

In the UK, digestates that are not certified under the Biofertiliser Certification Scheme are classed as 'wastes', thus, must be supplied, and transported according to duty of care requirements, by registered waste carriers.

In addition, uncertified digestates must be used under waste regulatory controls, which means that end users must hold the appropriate authorisation granted by the regulator to spread the digestates (e.g. waste management licence, environmental permit, or exemption from a waste management licence or environmental permit). Information about the waste regulatory controls that apply to the use of digestates can be found for:

a) England and Wales at http://www.environment-agency.gov.uk/business/topics/permitting/117161.aspx

b) Scotland at http://www.sepa.org.uk/waste/waste_regulation/application_forms/exempt_activities/paragraph_7.aspx

c) Northern Ireland at http://www.doeni.gov.uk/niea/waste-home/authorisation/exemption/wml_complex_exemptions/paragraph_9.htm

In order to obtain the relevant authorisation to spread the digestate, the organization responsible for the spreading activity must demonstrate that:

a) the landspreading activity will be carried out without causing a risk to the environment; and

b) the land treatment will result in agricultural benefit or ecological improvement.

Annex D: Heavy metal contents in composts, digestates and sewage sludges

The data below have been compiled from the input provided following the stakeholder survey in December 2010.

In order to allow comparison of the data, two levels of heavy metal content are shown:

- Median levels: i.e. 50 percentile levels or in the absence of these mean levels, assuming that for a normal distribution these values converge at large sample sizes
- 95 Percentile levels: in the absence of these replaced by the mean + 1.64 * standard deviation, assuming that for a normal distribution these values converge at large sample sizes

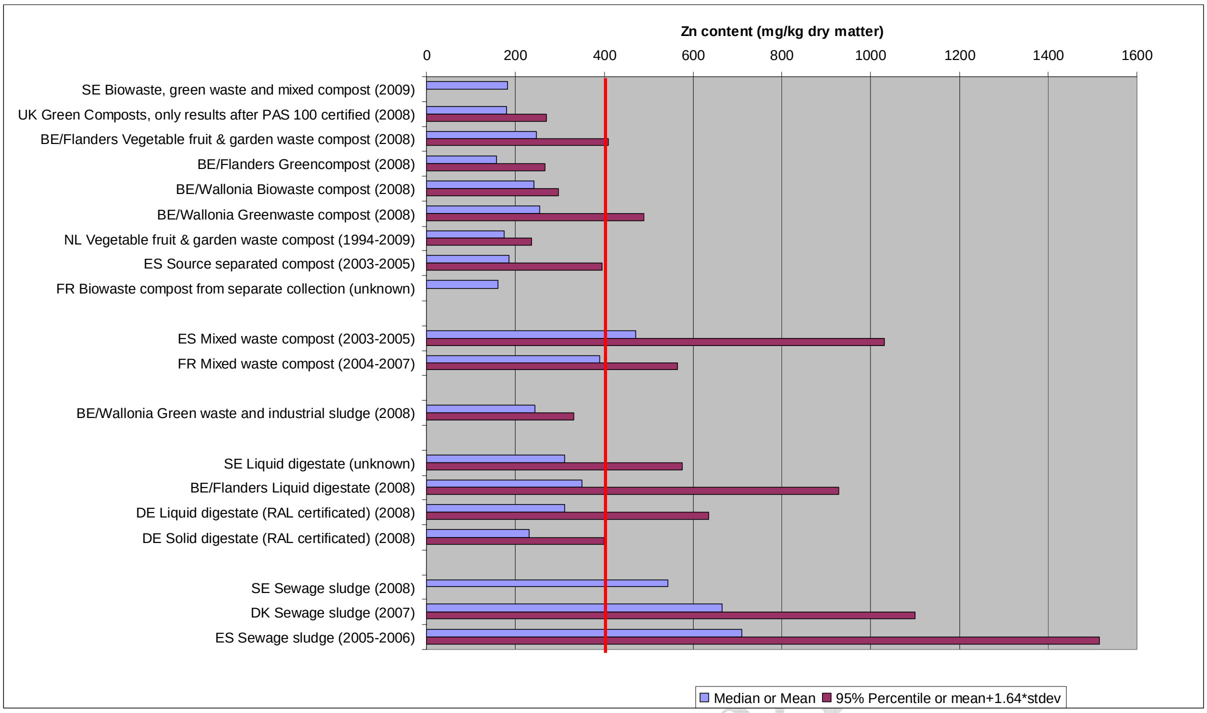
The data are presented in both a detailed table and a set of graphs, which also contain the proposed heavy metal limit values from the pilot study on compost (IPTS, 2008) as indicated by a thick red line.

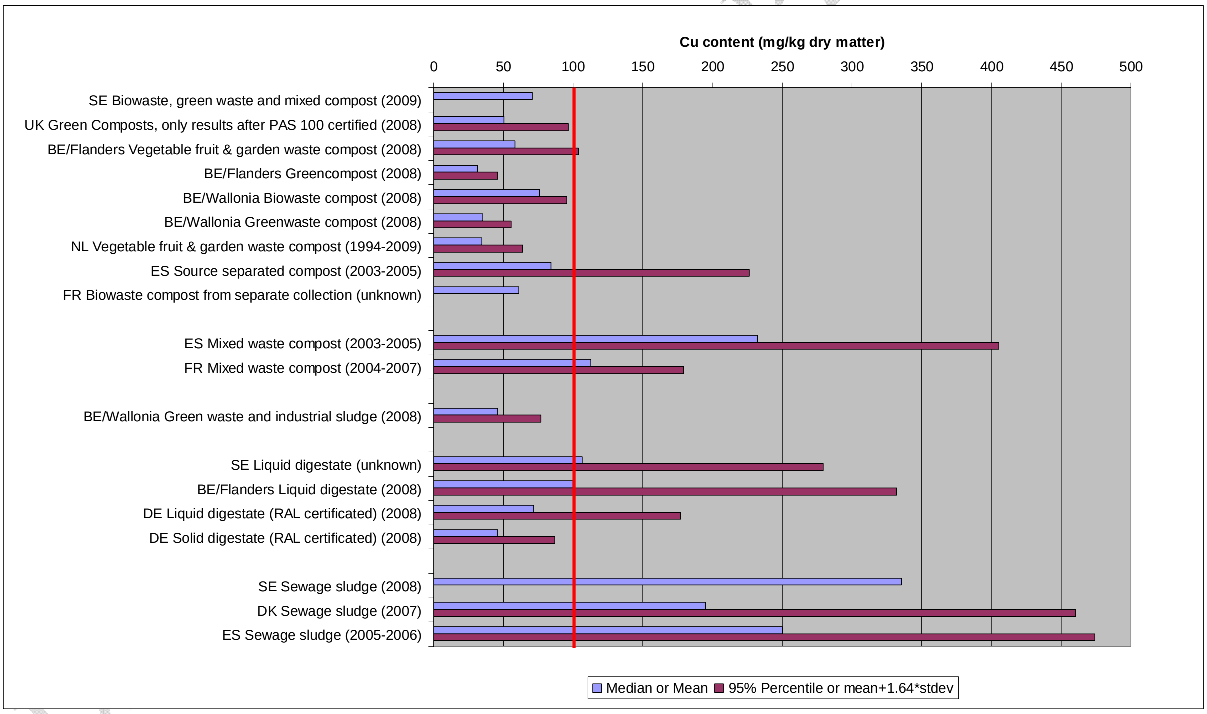
Mean or median

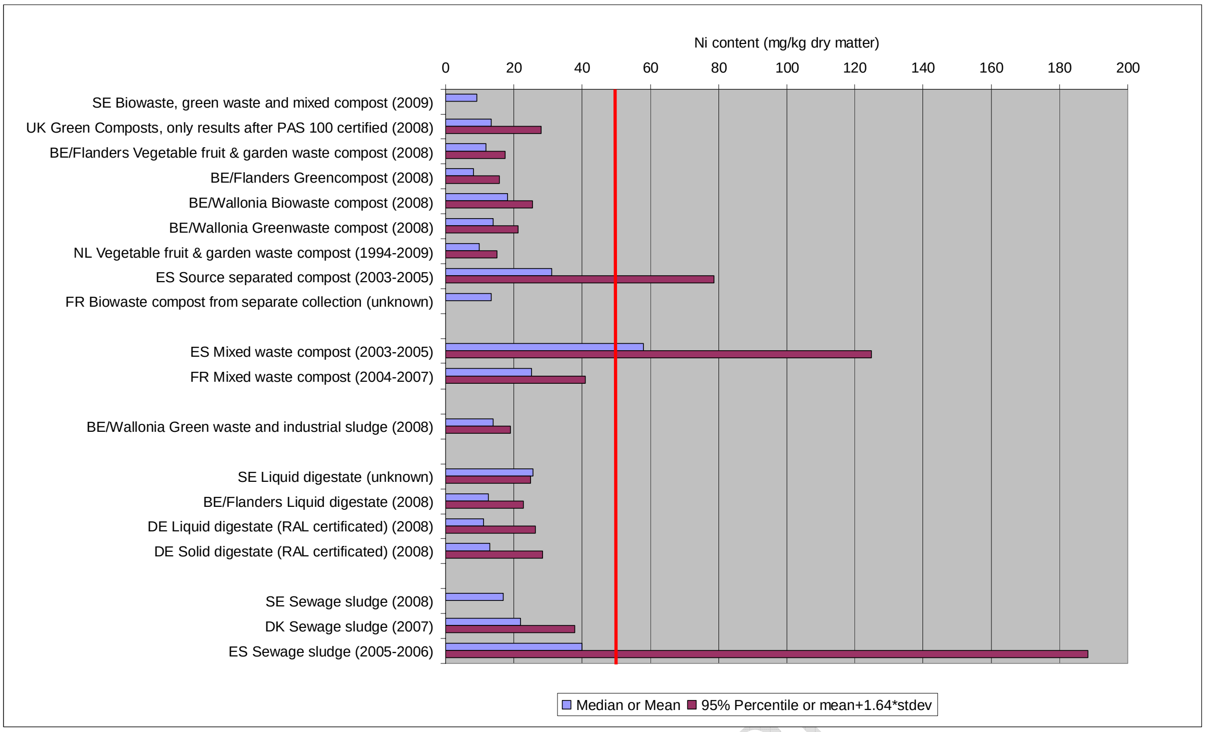
	Composts from source separated materials									MBT compost		Sludge compost	Digestate				Sewage sludge		
	Median	Median	Median	Median	Mean	Mean	Median	Median	Mean	Median	Median	Median	Median	Median	Median	Median	Mean	Median	Median
Zn (mg/kg dry matter)	182.3	180	248	157	241.1	253.5	175	186	160	472	391	243.2	311.6	350	311	231	544.3	665	710
Cu (mg/kg dry matter)	70.7	50.6	58.2	31.35	75.9	35.2	35	84	61.5	232	113	46.1	106.7	100	72	46	335.3	195	250
Ni (mg/kg dry matter)	9.1	13.4	11.75	8.3	18.1	13.9	10.0	31	13.5	58	25.2	14	25.6	12.55	11	13	16.9	22	40
Cd (mg/kg dry matter)	0.44	0.575	0.74	0.65	0.57	0.8	0.4	0.29	0.35	0.98	1.09	0.98	0.4	0.5	0.34	0.6	0.8	1	no data
Pb (mg/kg dry matter)	20.6	94	62.65	42	58.8	60.6	56	46	32	144	104	46.5	8.2	10	6	29	22.4	35	80
Hg (mg/kg dry matter)	0.1	0.15	0.11	0.11	0.15	0.14	0.08	0.2	0.2	0.93	0.4	0.2	0.14	0.09	0.09	0.12	0.6	0.8	1
Cr (mg/kg dry matter)	25.2	18.25	23.1	14	23.3	25.2	20	26	22.5	67	36.7	43.9	13.5	18	13	19	28.3	22	135
Member state	SE	UK	BE/Flanders	BE/Flanders	BE/Wallonia	BE/Wallonia	NL	ES	FR	ES	FR	BE/Wallonia	SE	BE/Flanders	DE	DE	SE	DK	ES
Material	Biowaste, green waste and mixed compost	Green Composts, only results after PAS 100 certified	Vegetable fruit & garden waste compost	Greencompost	Biowaste compost	Greenwaste compost	Vegetable fruit & garden waste compost	Source separated compost	Biowaste compost from separate collection	Mixed waste compost	Mixed waste compost	Green waste and industrial sludge	Liquid digestate	Liquid digestate	Liquid digestate (RAL certificated)	Solid digestate (RAL certificated)	Sewage sludge	Sewage sludge	Sewage sludge
Number of samples	12	100	unknown	unknown	unknown	unknown	1722	<77	unknown	<77	97	unknown	16	unknown	504	69	unknown	unknown	66
Source	SE	AFOR	BE	BE	BE	BE	DWMA	ES	ECN	ES	Veolia/ECN	BE	Muncipal waste Europe	BE	ECN	ECN	Eurocoop		ES
Year	2009	2008	2008	2008	2008	2008	1994-2009	2003-2005	unknown	2003-2005	2004-2007	2008	unknown	2008	2008	2008	2008	2007	2005-2006

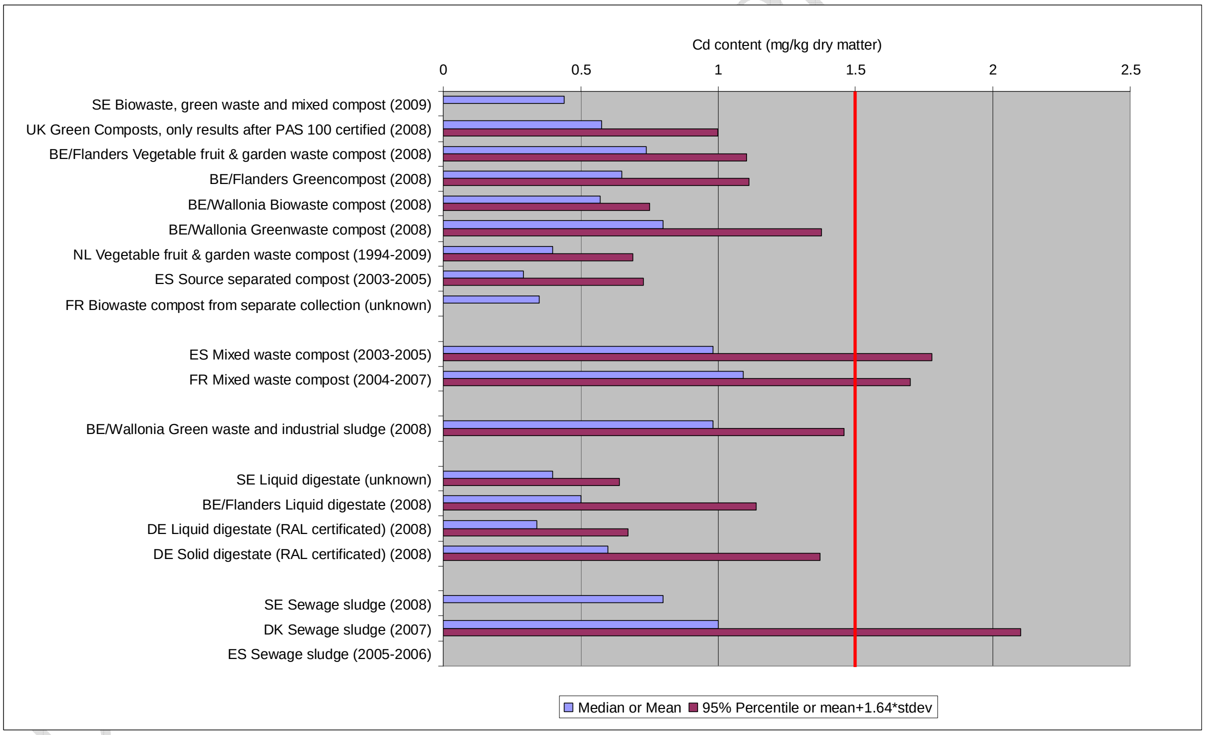
95% percentile or mean+1.64*stdev

	Composts from source separated materials									MBT compost		Sludge compost	Digestate				Sewage sludge		
		µ+1.64*σ	µ+1.64*σ	µ+1.64*σ	µ+1.64*σ	µ+1.64*σ	95%	µ+1.64*σ		µ+1.64*σ	95%	µ+1.64*σ	95%	µ+1.64*σ	95 % (*)	95 % (*)		95%	µ+1.64*σ
Zn (mg/kg dry matter)		270.2	409.1	267.1	296.3	488.6	236	395.8		1030.472	566	332.6	575	929.2	635.6	399.1		1100	1515.1
Cu (mg/kg dry matter)		96.7	103.8	46.1	95.3	55.4	64	226.3		405.112	179	77.0	279	332.3	177.2	87.1		460	474.1
Ni (mg/kg dry matter)		28.0	17.5	15.8	25.3	21.1	15	78.7		124.896	41	19.1	25	23.0	26.4	28.4		38	188.3
Cd (mg/kg dry matter)		1.0	1.1	1.1	0.8	1.4	0.69	0.7		1.77912	1.7	1.5	0.64	1.1	0.7	1.4		2.1	
Pb (mg/kg dry matter)		160.3	94.8	83.3	82.3	107.5	88	113.2		380.144	162	69.2	14.2	30.9	35.5	58.5		67	188.6
Hg (mg/kg dry matter)		0.5	0.4	0.2	0.2	0.3	0.2	2.8		3.57228	0.9	0.5	0.31	0.3	0.3	0.6		2.1	2.0
Cr (mg/kg dry matter)		39.9	40.5	32.2	29.7	46.9	32	68.2		179.352	70	76.0	26	57.7	33.5	49.8		52	
Member state		UK	BE/Flanders	BE/Flanders	BE/Wallonia	BE/Wallonia	NL	ES		ES	FR	BE/Wallonia	SE	BE/Flanders	DE	DE		DK	ES
Material		Green Composts, only results after PAS 100 certified	Vegetable fruit & garden waste compost	Greencompost	Biowaste compost	Greenwaste compost	Vegetable fruit & garden waste compost	Source separated compost		Mixed waste compost	Mixed waste compost	Green waste and industrial sludge	Liquid digestate		Liquid digestate (RAL certificated)	Solid digestate (RAL certificated)			
Number of samples		100	unknown	unknown	unknown	unknown	1722	<77		<77	97	unknown	16	unknown	504	69		unknown	66
Source		AFOR	BE	BE	BE	BE	DWMA	ES		ES	Veolia/ECN	BE	ECN	BE	ECN	ECN		DK	ES
Year		2008	2008	2008	2008	2008	1994-2009	2003-2005		2003-2005	2004-2007	2008	2009	2008	2008	2008		2007	2005-2006
															*Based on mean and 90%	*Based on mean and 90%			


Zn content (mg/kg dry matter)
0
200
400
600
800
1000
1200
1400
1600
SE Biowaste, green waste and mixed compost (2009)
UK Green Composts, only results after PAS 100 certified (2008)
BE/Flanders Vegetable fruit & garden waste compost (2008)
BE/Flanders Greencompost (2008)
BE/Wallonia Biowaste compost (2008)
BE/Wallonia Greenwaste compost (2008)
NL Vegetable fruit & garden waste compost (1994-2009)
ES Source separated compost (2003-2005)
FR Biowaste compost from separate collection (unknown)
ES Mixed waste compost (2003-2005)
FR Mixed waste compost (2004-2007)
BE/Wallonia Green waste and industrial sludge (2008)
SE Liquid digestate (unknown)
BE/Flanders Liquid digestate (2008)
DE Liquid digestate (RAL certificated) (2008)
DE Solid digestate (RAL certificated) (2008)
SE Sewage sludge (2008)
DK Sewage sludge (2007)
ES Sewage sludge (2005-2006)
Median or Mean
95% Percentile or mean+1.64*stdev


Cu content (mg/kg dry matter)
0
50
100
150
200
250
300
350
400
450
500
SE Biowaste, green waste and mixed compost (2009)
UK Green Composts, only results after PAS 100 certified (2008)
BE/Flanders Vegetable fruit & garden waste compost (2008)
BE/Flanders Greencompost (2008)
BE/Wallonia Biowaste compost (2008)
BE/Wallonia Greenwaste compost (2008)
NL Vegetable fruit & garden waste compost (1994-2009)
ES Source separated compost (2003-2005)
FR Biowaste compost from separate collection (unknown)
ES Mixed waste compost (2003-2005)
FR Mixed waste compost (2004-2007)
BE/Wallonia Green waste and industrial sludge (2008)
SE Liquid digestate (unknown)
BE/Flanders Liquid digestate (2008)
DE Liquid digestate (RAL certificated) (2008)
DE Solid digestate (RAL certificated) (2008)
SE Sewage sludge (2008)
DK Sewage sludge (2007)
ES Sewage sludge (2005-2006)
Median or Mean
95% Percentile or mean+1.64*stdev


Ni content (mg/kg dry matter)
0
20
40
60
80
100
120
140
160
180
200
SE Biowaste, green waste and mixed compost (2009)
UK Green Composts, only results after PAS 100 certified (2008)
BE/Flanders Vegetable fruit & garden waste compost (2008)
BE/Flanders Greencompost (2008)
BE/Wallonia Biowaste compost (2008)
BE/Wallonia Greenwaste compost (2008)
NL Vegetable fruit & garden waste compost (1994-2009)
ES Source separated compost (2003-2005)
FR Biowaste compost from separate collection (unknown)
ES Mixed waste compost (2003-2005)
FR Mixed waste compost (2004-2007)
BE/Wallonia Green waste and industrial sludge (2008)
SE Liquid digestate (unknown)
BE/Flanders Liquid digestate (2008)
DE Liquid digestate (RAL certificated) (2008)
DE Solid digestate (RAL certificated) (2008)
SE Sewage sludge (2008)
DK Sewage sludge (2007)
ES Sewage sludge (2005-2006)
Median or Mean
95% Percentile or mean+1.64*stdev


Cd content (mg/kg dry matter)
0
0.5
1
1.5
2
2.5
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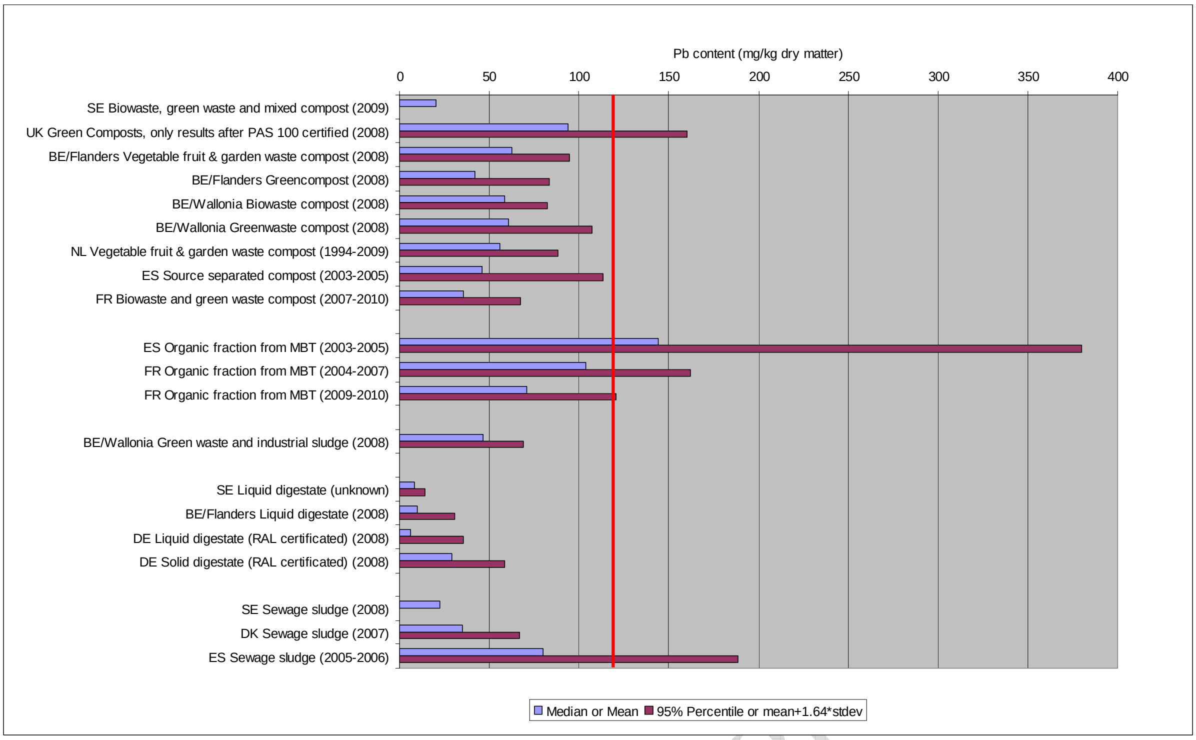
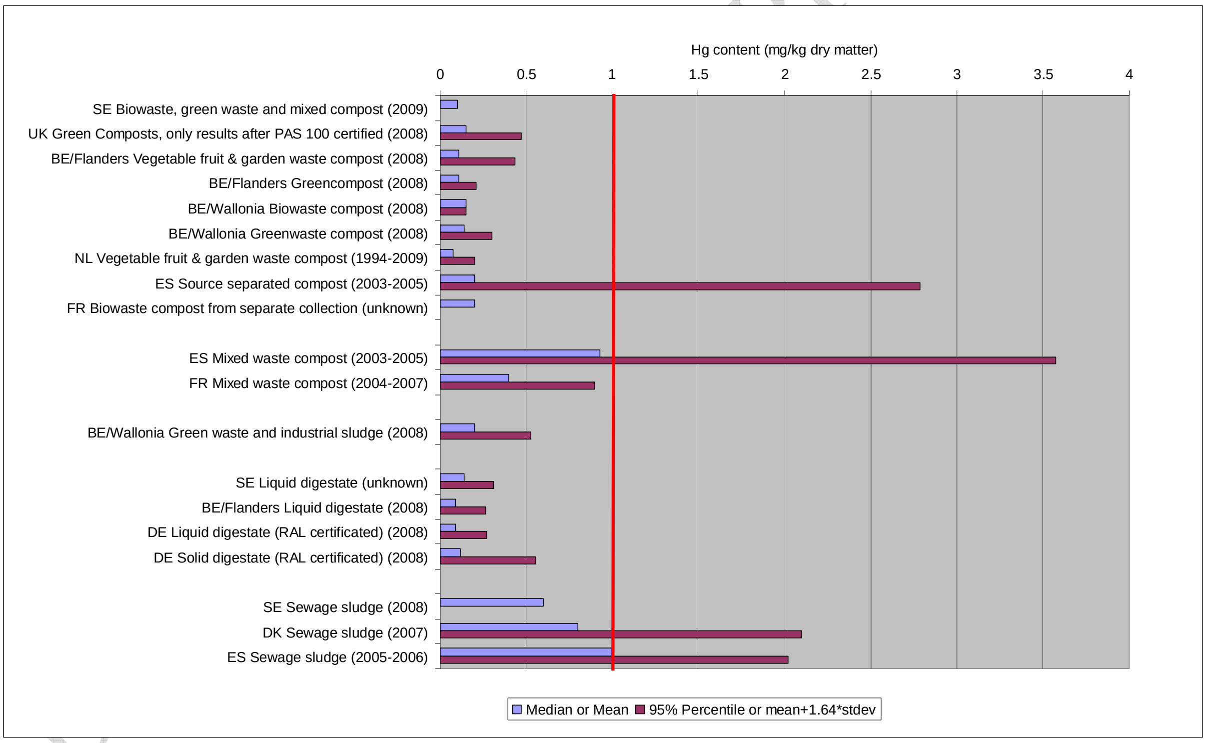
UK Green Composts, only results after PAS 100 certified (2008)
BE/Flanders Vegetable fruit & garden waste compost (2008)
BE/Flanders Greencompost (2008)
BE/Wallonia Biowaste compost (2008)
BE/Wallonia Greenwaste compost (2008)
NL Vegetable fruit & garden waste compost (1994-2009)
ES Source separated compost (2003-2005)
FR Biowaste compost from separate collection (unknown)
ES Mixed waste compost (2003-2005)
FR Mixed waste compost (2004-2007)
BE/Wallonia Green waste and industrial sludge (2008)
SE Liquid digestate (unknown)
BE/Flanders Liquid digestate (2008)
DE Liquid digestate (RAL certificated) (2008)
DE Solid digestate (RAL certificated) (2008)
SE Sewage sludge (2008)
DK Sewage sludge (2007)
ES Sewage sludge (2005-2006)
Median or Mean
95% Percentile or mean+1.64*stdev


Pb content (mg/kg dry matter)
0
50
100
150
200
250
300
350
400
SE Biowaste, green waste and mixed compost (2009)
UK Green Composts, only results after PAS 100 certified (2008)
BE/Flanders Vegetable fruit & garden waste compost (2008)
BE/Flanders Greencompost (2008)
BE/Wallonia Biowaste compost (2008)
BE/Wallonia Greenwaste compost (2008)
NL Vegetable fruit & garden waste compost (1994-2009)
ES Source separated compost (2003-2005)
FR Biowaste and green waste compost (2007-2010)
ES Organic fraction from MBT (2003-2005)
FR Organic fraction from MBT (2004-2007)
FR Organic fraction from MBT (2009-2010)
BE/Wallonia Green waste and industrial sludge (2008)
SE Liquid digestate (unknown)
BE/Flanders Liquid digestate (2008)
DE Liquid digestate (RAL certificated) (2008)
DE Solid digestate (RAL certificated) (2008)
SE Sewage sludge (2008)
DK Sewage sludge (2007)
ES Sewage sludge (2005-2006)
Median or Mean
95% Percentile or mean+1.64*stdev


Hg content (mg/kg dry matter)
0
0.5
1
1.5
2
2.5
3
3.5
4
SE Biowaste, green waste and mixed compost (2009)
UK Green Composts, only results after PAS 100 certified (2008)
BE/Flanders Vegetable fruit & garden waste compost (2008)
BE/Flanders Greencompost (2008)
BE/Wallonia Biowaste compost (2008)
BE/Wallonia Greenwaste compost (2008)
NL Vegetable fruit & garden waste compost (1994-2009)
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FR Biowaste compost from separate collection (unknown)
ES Mixed waste compost (2003-2005)
FR Mixed waste compost (2004-2007)
BE/Wallonia Green waste and industrial sludge (2008)
SE Liquid digestate (unknown)
BE/Flanders Liquid digestate (2008)
DE Liquid digestate (RAL certificated) (2008)
DE Solid digestate (RAL certificated) (2008)
SE Sewage sludge (2008)
DK Sewage sludge (2007)
ES Sewage sludge (2005-2006)
Median or Mean
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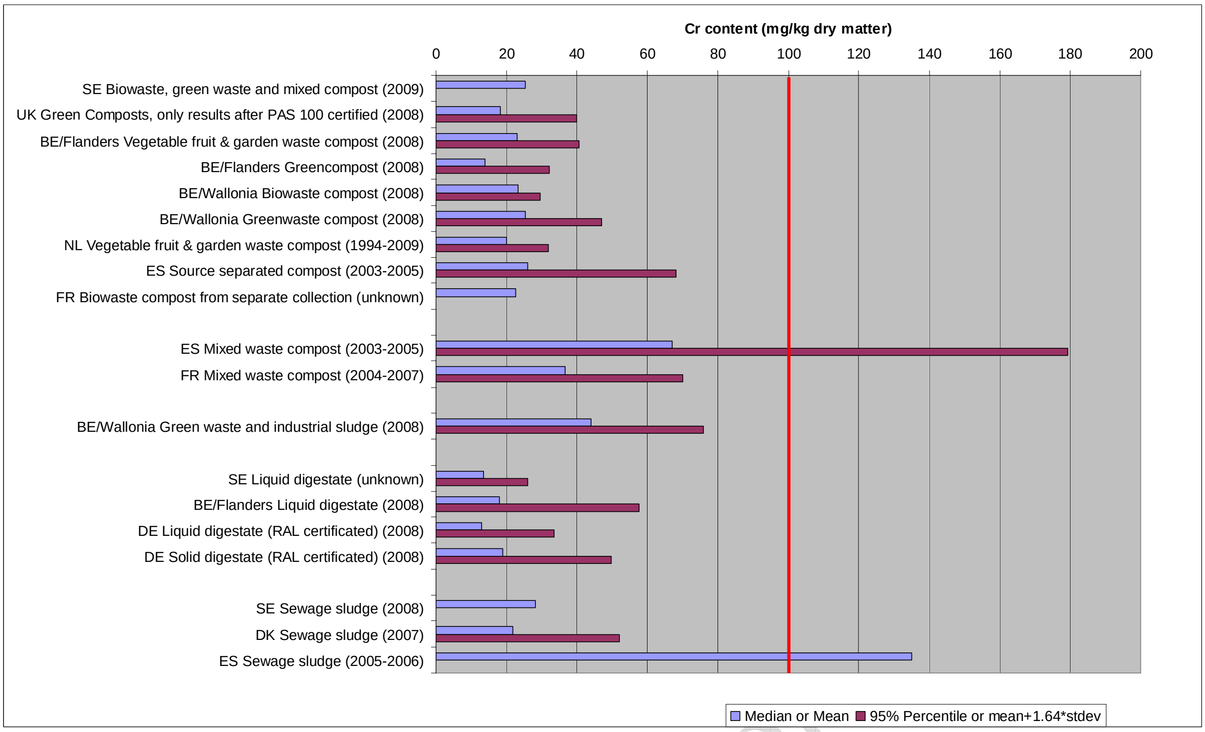
Cr content (mg/kg dry matter)
0
20
40
60
80
100
120
140
160
180
200
SE Biowaste, green waste and mixed compost (2009)
UK Green Composts, only results after PAS 100 certified (2008)
BE/Flanders Vegetable fruit & garden waste compost (2008)
BE/Flanders Greencompost (2008)
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SE Sewage sludge (2008)
DK Sewage sludge (2007)
ES Sewage sludge (2005-2006)
Median or Mean
95% Percentile or mean+1.64*stdev

Annex E: Suggested other materials for End of Waste status following stakeholder survey of December 2010 and major reasons for non-eligibility

Material	Major reasons for exclusion from EoW status
Manure not subject to composting or anaerobic digestion	• Manure not subject to digestion or composting is not considered to be a waste material
Untreated biodegradable waste	• Hygienic safety is not guaranteed • Stability is not guaranteed • Market/demand is little developed
Raw sewage sludge	• Hygienic safety is not guaranteed • Stability is not guaranteed • High contamination with heavy metals (e.g. max 10% of Danish sewage sludge would meet currently proposed heavy metal limits for EoW, see Table below) • Market/demand is little developed

Percentile values of heavy metal concentrations and organic pollutants in Danish sewage sludge (2007 data, source: DK answer to stakeholder survey December 2010). Green shading indicates the compliance with currently proposed heavy metal limit concentrations for EoW

Parameter	Unit	5 % Percentile	10 % Percentile	20 % Percentile	30 % Percentile	40 % Percentile	50 % Percentile	60 % Percentile	70 % Percentile	80 % Percentile	90 % Percentile	95 % Percentile
Zn	mg/kg DM	341	400	515	550	620	665	728	795	880	970	1100
Cu	mg/kg DM	84	100	130	145	170	195	230	270	305	410	460
Ni	mg/kg DM	11	13	16	18	20	22	24	25	29	34	38
Cd	mg/kg DM	0.5	0.6	0.7	0.8	0.9	1	1.1	1.2	1.5	1.7	2.1
Pb	mg/kg DM	13	19	25	29	33	35	36	42	47	58	67
Hg	mg/kg DM	0.3	0.4	0.5	0.6	0.7	0.8	1	1.2	1.4	1.8	2.1
Cr	mg/kg DM	11	14	16	18	19	22	24	26	29	39	52
As	mg/kg DM	5	5	6	8	8	11	11	12	14	17	17
LAS	mg/kg DM	25	50	50	50	50	69	82	140	355	820	880
PAH	mg/kg DM	0.4	0.5	0.6	0.8	1	1.1	1.3	1.5	1.8	2.3	2.6
NPE	mg/kg DM	0.7	0.9	1.2	1.6	2.1	2.6	3.2	4.4	5.8	10	13
DEHP	mg/kg DM	1.8	4.1	5.4	6.6	8	9.2	11	13	14.5	19.1	24