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**GREEN PAPER**

**On the management of bio-waste in the European Union**

{SEC(2008) 2936}

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## On the management of bio-waste in the European Union

### 1. INTRODUCTION

Growth in the EU is still accompanied by increasing amounts of waste, causing unnecessary losses of materials and energy, environmental damage and negative effects on health and quality of life. It is a strategic goal of the EU to reduce these negative impacts, turning the EU into a resource efficient "Recycling Society"<sup>1</sup>.

Waste management is already governed by a substantial body of regulation but there remain opportunities for further improving the management of some major waste streams.

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. It does not include forestry or agricultural residues, manure, sewage sludge, or other biodegradable waste such as natural textiles, paper or processed wood. It also excludes those by-products of food production that never become waste<sup>2</sup>.

The total annual arising of bio-waste in the EU is estimated at 76.5-102 Mt food and garden waste included in mixed municipal solid waste<sup>3</sup> and up to 37 Mt from the food and drink industry. Bio-waste is a putrescible, generally wet waste. There are two major streams – green waste from parks, gardens etc. and kitchen waste. The former includes usually 50-60% water and more wood (lignocellulosis), the latter contains no wood but up to 80% water.

Waste management options for bio-waste include, in addition to prevention at source, collection (separately or with mixed waste), anaerobic digestion and composting, incineration, and landfilling. The environmental and economic benefits of different treatment methods depend significantly on local conditions such as population density, infrastructure and climate as well as on markets for associated products (energy and composts).

Today, very different national policies apply to bio-waste management, ranging from little action in some Member States to ambitious policies in others. This can lead to increased environmental impacts and can hamper or delay full utilisation of advanced bio-waste management techniques. It should be investigated whether action on national level would be sufficient to ensure proper bio-waste management in the EU, or whether Community action is needed. This Green Paper aims to discuss these questions and prepare grounds for the upcoming impact assessment which will also address the subsidiarity issue.

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<sup>1</sup> See: COM(2001) 264, COM(2005) 670, COM(2005) 666.

<sup>2</sup> COM(2007) 59.

<sup>3</sup> Estimation based on Eurostat data on municipal waste (2008).

## 2. OBJECTIVES OF THE GREEN PAPER

The revised Waste Framework Directive<sup>4</sup> calls upon the Commission to carry out an assessment of the management of bio-waste, with a view to submitting a proposal, if appropriate.

Bio-waste management in the Community has already been discussed in two working papers issued by the Commission between 1999 and 2001. The situation has since changed substantially: 12 new Member States with specific waste management practices have joined the EU, technological progress and new research results need to be considered, new orientations (e.g. in soil and energy policy) need to be factored in.

This Green Paper aims to explore options for the further development of the management of bio-waste. It summarizes important background information about current policies on bio-waste management and new research findings in the field, presents core issues for debate, and invites stakeholders to contribute their knowledge and views on the way forward. It aims to prepare a debate on the possible need for future policy action, seeking views on how to improve bio-waste management in line with the waste hierarchy, possible economic, social and environmental gains, as well as the most efficient policy instruments to reach this objective.

It is clear that major data difficulties and uncertainties exist with regards to bio-waste management options, highlighted throughout the Paper. The Commission would therefore like to invite all Stakeholders to provide any data available to facilitate the subsequent Impact Assessment of different bio-waste management options.

## 3. STATE OF PLAY IN BIO-WASTE MANAGEMENT

### 3.1. Current techniques

**Separate collection** schemes function successfully in many countries especially for green waste. The kitchen waste are more often collected and treated as part of the mixed Municipal Solid Waste (MSW). The benefits of separate collection can include diverting easily biodegradable waste from landfills, enhancing the calorific value of the remaining MSW, and generating a cleaner bio-waste fraction that allows to produce high quality compost and facilitates biogas production. Separate collection of bio-waste is also expected to support other forms of recycling likely to be available on the market in the near future (e.g. production of chemicals in bio-refineries).

**Landfilling**, although according to the waste hierarchy the worst option, is still the most used MSW disposal method in the EU. Landfills need to be constructed and operated in line with the EU Landfill Directive<sup>5</sup> (impermeable barriers, methane capturing equipment) to avoid environmental damage from the generation of methane and effluent.

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<sup>4</sup> Revised Waste Framework Directive (2005/0281(COD)).

<sup>5</sup> Directive 1999/31/EC.

**Incineration:** bio-waste is usually incinerated as part of MSW. Depending on its energy efficiency,<sup>6</sup> incineration can be regarded as energy recovery or as a disposal. As the efficiency of incineration is lowered by the moist bio-waste, it can be beneficial to remove bio-waste from municipal waste<sup>7</sup>. On the other hand, incinerated bio-waste is regarded as carbon-neutral “renewable” fuel in the meaning of the renewable electricity directive<sup>8</sup> and the proposed Directive on the promotion of the use of energy from renewable sources (RES Directive)<sup>9</sup>.

**Biological treatment** (including composting and anaerobic digestion) may be classified as recycling when compost (or digestate) is used on land or for the production of growing media. If no such use is envisaged it should be classified as pre-treatment before landfilling or incineration. In addition, anaerobic digestion (producing biogas for energy purposes) should be seen as energy recovery.

Composting is the most common biological treatment option (some 95% of current biological treatment operations<sup>10</sup>). It is best suited for green waste and woody material. There are different methods of which the "closed methods" are more expensive but less space-demanding, faster, and stricter in terms of process emissions control (odours, bio-aerosols).

Anaerobic digestion is especially suitable for treating wet bio-waste, including fat (e.g. kitchen waste). It produces a gas mixture (mainly methane - 50 to 75% - and carbon dioxide) in controlled reactors.

Biogas can reduce greenhouse gas (GHG) emissions most significantly if used as a biofuel for transport or directly injected into the gas distribution grid. Its use as biofuel could result in significant reductions of GHG emissions, showing a net advantage with respect to other transport fuels<sup>11</sup>.

The residue from the process, the digestate, can be composted and use for similar purpose as compost, thus improving overall resource recovery from waste.

If not stated otherwise, the term "compost" in this document refers both to compost directly produced from biowaste as well as composted digestate.

**Mechanical-Biological Treatment (MBT)** describes techniques which combine biological treatment with mechanical treatment (sorting). In this paper the term refers only to the pre-treatment of mixed waste with the objective to produce either a more stable input to landfills or a product with improved combustion properties. However, MBT using anaerobic digestion generates biogas and thus can also be an energy recovery process. Combustible waste sorted out in MBT processes may be further incinerated because of its energy recovery potential.

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<sup>6</sup> According to Annex II of the Waste Framework Directive, incineration facilities dedicated to the processing of MSW are regarded as recovery operation only where their energy efficiency is equal to or above 0.60 for installations in operation before 1 January 2009 and 0.65 for installations permitted after 31 December 2008.

<sup>7</sup> The pre-treated waste fraction for incineration is often referred to as RDF (refuse derived fuel).  
<sup>8</sup> Directive 2001/77/EC.

<sup>9</sup> COM(2008) 19.

<sup>10</sup> ORBIT/ECN, 2008.

<sup>11</sup> In 2007, the largest European centre for biogas as biofuel opened in Lille. Based on the treatment of the separated organic waste collected by this municipality of 1.1 million people, it will produce 4 million Nm<sup>3</sup> of biogas per year converted to transport-grade fuel, serving a fleet of 150 buses of the municipal transport system.

### 3.2. Current management in EU Member States

There are large differences between Member States in MSW and bio-waste management. The report of the European Environment Agency<sup>12</sup> distinguishes three main approaches:

- Countries relying heavily on incineration to divert waste from landfills, accompanied by a high level of material recovery and often advanced strategies promoting biological treatment of waste: DK, SE, BE (Flanders), NL, LU, FR.
- Countries with high material recovery rates but relatively low incineration: DE, AT, ES, IT, some achieving the highest composting rates in the EU (DE, AT), others quickly developing their composting and MBT capacities.
- Countries relying on landfills, where landfill diversion remains a major challenge due to lack of capacity: a number of new Member States.

Candidate and potential candidate countries also rely mainly on landfilling and in their case diversion of biodegradable waste from landfills will be a major challenge.

**Landfilling:** In the EU bio-waste constitutes usually between 30% and 40% (but ranges from 18% up to 60%) of MSW,<sup>13</sup> most of which is treated by options ranking low in the waste hierarchy. On average 41% of MSW is landfilled,<sup>14</sup> while in some Member States (e.g. PL, LT) this percentage exceeds 90%. However, as a result of national policies and the Landfill Directive which requires diversion of bio-waste from landfills, the EU average amount of landfilled MSW has dropped from 288 to 213 kg/capita/year (from 55 to 41%) since the year 2000.

**Incineration** reaches a share of 47% in Sweden and 55% in Denmark<sup>15</sup>. In both countries, incineration of bio-waste that is not separately collected is usually carried out by means of cogeneration of electricity and heat and with flue gas condensation, leading to high efficiency and high net energy recovery.

Mechanical-Biological Treatment has been used across the EU over the last 10 years as pre-treatment to comply with landfill acceptance criteria or to enhance the calorific value for incineration. In 2005, not less than 80 large facilities existed of a combined capacity of more than 8.5 million tonnes, most in DE, ES and IT<sup>16</sup>.

For biological treatment of organic waste in general (not only for bio-waste) a total of 6 000 installations have been identified, including 3 500 composting and 2 500 anaerobic digestion (AD) facilities (mostly small scale on-farm units). 124 AD installation for treatment of bio-waste and/or municipal waste (including AD-based MBT installations) with a total capacity of 3.9 million tonnes, were operational in 2006 and this number is expected to grow<sup>17</sup>.

**Recycling** is supported by **separate collection** in certain Member States (AT, NL, DE, SE and parts of BE (Flanders), ES (Catalonia) and IT (northern regions), while others (CZ, DK,

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<sup>12</sup> EEA, 2007 (1).

<sup>13</sup> See ACR+, 2008 and JRC, 2007.

<sup>14</sup> This and further data on landfilling – Eurostat, 2008.

<sup>15</sup> Eurostat, 2008.

<sup>16</sup> Juniper, 2005.

<sup>17</sup> L.de Baere, 2008.

FR) focus on composting green waste and collect kitchen waste with MSW. In all regions where separate collection has been introduced it is regarded a successful waste management option<sup>18</sup>.

The overall potential for separately collected bio-waste is estimated at up to 150kg/inhabitant/year, including kitchen and garden waste from households, park and garden waste from public estates, and waste from the food industry<sup>19</sup> (80 Mt for EU27). About 30% of this potential (24 Mt) are currently collected separately and treated biologically.<sup>20</sup> The total production of compost was 13.2 Mt in 2005. Most of it was produced from bio-waste (4.8 Mt) and green waste (5.7 Mt), the rest from sewage sludge (1.4 Mt) and mixed waste (1.4 Mt). The potential of compost production from most valuable inputs (bio-waste and green waste) is estimated at 35 to 40 Mt<sup>21</sup>.

Compost is used in agriculture (about 50%), for landscaping (up to 20%), to produce growing media (blends) and manufactured soil (around 20%), and by private consumers (up to 25%)<sup>22</sup>. Countries which produce compost predominantly from mixed waste and have undeveloped compost markets tend to use it in agriculture (ES, FR) or for land restoration or landfill cover (FI, IE, PL<sup>23</sup>).

The demand for compost varies in Europe depending mostly on soil improvement needs, and consumer confidence. EU soil policy calling on the Commission and the Parliament to act against the degradation of soil<sup>24</sup> as well as increasing consumer confidence in relation to the safe use of composts from waste could enhance demand significantly.

However, the use of compost and digestate from waste have limited capacity to solve the soil quality problem in the EU as at a typical compost application rate of 10 tonnes of compost per hectare and year only 3.2% of agricultural land could be upgraded even if all bio-waste was composted and used<sup>25</sup>, while significant long-distance transport with its negative implications on cost and environmental burdens would be necessary.

### **3.3. EU legal instruments regulating the treatment of bio-waste**

A number of EU legal instruments address the issue of treatment of bio-waste. General waste management requirements such as environmental and human health protection during waste treatment and priority for waste recycling are laid down in the revised Waste Framework Directive which also contains specific bio-waste related elements (new recycling targets for household waste, which can include bio-waste) and a mechanism allowing setting quality criteria for compost. Landfilling of bio-waste is addressed in the landfill Directive which requires the diversion of biodegradable municipal waste from landfills. The revised IPPC Directive laying down the main principles for the permitting and control of bio-waste treatment installations will cover all biological treatment of organic waste above a capacity of 50 tonnes/day. The incineration of bio-waste is regulated in the Waste Incineration Directive while the health rules for composting and biogas plants which treat animal by-products are

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<sup>18</sup> see e.g. [http://ec.europa.eu/environment/waste/publications/compost\\_success\\_stories.htm](http://ec.europa.eu/environment/waste/publications/compost_success_stories.htm).

<sup>19</sup> ORBIT/ECN, 2008.

<sup>20</sup> ORBIT/ECN, 2008.

<sup>21</sup> Every tonne of bio-waste results in the production of about 350-400 kg of compost.

<sup>22</sup> ORBIT/ECN, 2008 – due to very general data no sum up to 100%.

<sup>23</sup> In PL, 100% of compost is used for land restoration or covering landfills due to poor compost quality.

<sup>24</sup> COM(2006) 231 and 2006/2293(INI).

<sup>25</sup> ORBIT/ECN, 2008.

laid down in the Animal By-products Regulation. The proposed RES Directive also contains measures on how bio-wastes are to be counted towards renewable energy targets. EU legislation does not limit Member States' choices of bio-waste treatment options as long as they respect certain framework conditions, notably those set by the Waste Framework Directive. The choice of treatment options needs to be explained and justified in national or regional Waste Management Plans and Prevention Programmes. Together with a definition of waste which, before the revision of the Waste Framework Directive did not set clear boundaries for when a waste has been adequately treated and should be considered a product, this has led to a wide variety of policies and treatment methods in the EU, including different interpretations of Member States as to when treated bio-waste may cease to be waste and become a product that can move freely on the internal market or be exported from the EU.

### 3.4. EU legal instruments regulating the use of bio-waste

**Compost:** Standards on the use and quality of compost exist in most Member States, but differ substantially, partly due to differences in soil policies. While there is no comprehensive Community legislation, certain rules regulate specific aspects of bio-waste treatment, biogas production and compost use.

The *Organic Farming Regulation*<sup>26</sup> lays down conditions for the use of compost in organic farming.

The *eco-labels* for soil improvers<sup>27</sup> and for growing media<sup>28</sup> specify limits for contaminants and require that the compost be of waste origin only.

The *Thematic Strategy for Soil Protection*<sup>29</sup> calls for the use of compost as one of the best sources of stable organic matter from which new humus can be formed in degraded soils. An estimated 45% of European soils have low organic matter content, principally in southern Europe but also in areas of France, the UK and Germany.

**Energy recovery:** Based on a Community-wide commitment to reaching a target of 20% share of renewable energy in final energy consumption by 2020<sup>30</sup>, the European Commission proposed a RES Directive to replace existing Directives on the promotion of renewable electricity (Directive 2001/77/EC) and biofuels (Directive 2003/30/EC).<sup>31</sup> The proposal strongly supports the use of all types of biomass, including bio-waste for energy purposes, and requires Member States to develop National Action Plans to outline national policies to develop existing biomass resources and mobilise new biomass resources for different uses.

The Renewable Energy Road Map<sup>32</sup> projected that around 195 million tonnes of oil equivalent (Mtoe) of biomass will be used in 2020 to achieve the 20% renewable energy target. A report by the European Environment Agency<sup>33</sup> found that the potential for bio-energy from the MSW is 20 Mtoe – which would account for around 7% of all renewable energy in 2020), assuming that all wastes which are currently landfilled would become available for

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<sup>26</sup> Regulations 2092/91/EEC (until 31.12.2008) and 834/2007/EC (as from 1.1.2009).

<sup>27</sup> Decision 2006/799/EC.

<sup>28</sup> Decision 2007/64/EC.

<sup>29</sup> COM(2006) 231.

<sup>30</sup> Brussels European Council of March 2007.

<sup>31</sup> The RES Directive is currently negotiated under a co-decision procedure between the European Parliament and the Council.

<sup>32</sup> COM(2006) 848.

<sup>33</sup> EEA, 2006.

incineration with energy recovery and waste which are composted will be subject to anaerobic digestion first and then composted.

#### 4. ENVIRONMENTAL, ECONOMIC AND SOCIAL ISSUES RELATED TO BIO-WASTE MANAGEMENT

##### 4.1. Environmental impacts

**Landfilling:** Biodegradable waste decomposes in landfills to produce landfill gas and leachate. The landfill gas, if not captured, contributes considerably to the greenhouse effect as it consists mainly of methane, which is 23 times more powerful than carbon dioxide in terms of climate change effects in the 100-years time horizon considered by the Intergovernmental Panel on Climate Change (IPCC).<sup>34</sup> Before adoption of the Landfill Directive, methane emissions from landfills accounted for 30% of the global anthropogenic emissions of methane into the atmosphere.<sup>35</sup> Assuming that all countries comply with the Landfill Directive, even if the total amount of MSW increases, by 2020 the expected emissions of methane in CO<sub>2</sub> equivalents will be 10 Mt lower than in 2000.<sup>36</sup> The leachate, if not collected in accordance with the Landfill Directive, can contaminate groundwater and soil. Landfills may also be a source of nuisance for neighbouring areas as they generate bio-aerosols, odours, and visual disturbance. Yet another negative impact of landfilling is the area of land used, which is bigger than for other waste management methods. There are hardly any positive aspects of landfilling biodegradable with the possible exception of "storage" capacity for carbon sequestered in pre-treated waste<sup>37</sup> and very limited energy production from collected landfill gas if landfill is carefully managed. The main negative impacts of landfilling will be reduced by adhering to the EU Landfill Directive, but not eliminated. Also, landfilling means irrecoverable loss of resources and land, in the medium to long term it is not considered a sustainable waste management solution and is not favoured.

**Incineration** of bio-waste as a part of mixed municipal waste may be used to recover energy from a carbon-neutral source, providing an alternative to e.g. fossil fuels and contributing to climate change. However, the energy efficiency of current MSW incinerators varies considerably, depending mainly on whether an incineration plant delivers heat, electricity, or both in combined heat and power plants<sup>38</sup> as well as technology used (e.g. flue gas condensation allows to achieve higher efficiency). The revised Waste Framework Directive encourages a shift to highly efficient new plants.

The European Commission has launched a public consultation about developing a sustainability scheme for biomass, where the end-use efficiency of converting biomass to heat and electricity is a central issue<sup>39</sup>.

The environmental impacts of incinerating MSW containing biodegradable waste are mainly related to airborne emissions from incinerators, including greenhouse gas emissions, loss of organic matter and other resources contained in biomass. Compliance with the Waste

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<sup>34</sup> www.ipcc.ch

<sup>35</sup> COM(96) 557.

<sup>36</sup> EEA, 2007 (2) (fig. 6.24).

<sup>37</sup> AEA, 2001.

<sup>38</sup> Eunomia (2002) assumed that representative (for EU15) incinerator producing only electricity achieves 21% energy efficiency and CHP plants generate energy at 75% efficiency.

<sup>39</sup> [http://ec.europa.eu/energy/res/consultation/uses\\_biomass\\_en.htm](http://ec.europa.eu/energy/res/consultation/uses_biomass_en.htm)

Incineration Directive limits emissions of selected heavy metals and a range of other emissions including dioxins as far as practicable and requires reduction of any health risks. Nevertheless, some emissions will occur. There will also be some environmental burden from the disposal of ashes and slags, for example the flue gas cleaning residues, which often have to be disposed of as hazardous waste.

The emissions from MSW incineration are reduced to the minimum by the Incineration Directive. The overall environmental performance of incineration of MSW, including bio-waste, depends on many factors (especially fuel quality, energy efficiency of installations and source of replaced energy).

**Biological treatment:** Composting, anaerobic digestion and mechanical-biological treatment also produce emissions (including greenhouse gases CH<sub>4</sub>, N<sub>2</sub>O and CO<sub>2</sub>). After stabilisation through biological treatment, the resulting material binds short cycle carbon for a limited time: it is estimated that in the 100-year horizon about 8% of the organic matter present in compost will stay as humus in the soil<sup>40</sup>.

The use of compost and digestate as soil improvers and fertilizers offers agronomic benefits<sup>41</sup> such as improvement of soil structure, moisture infiltration, water-holding capacity, soil microorganisms and supply with nutrients (on average, compost from kitchen waste contains about 1% N, 0.7% P<sub>2</sub>O<sub>5</sub> and 6.5% K<sub>2</sub>O). In particular the recycling of phosphorous can reduce the need to import mineral fertilizer while replacement of peat shall reduce damage to wetland eco-systems.

Increased water retention capacity improves workability of soils, thereby reducing energy consumption when ploughing them. Better water retention (soil organic matter can absorb up to 20 times its weight in water) can help to counteract the desertification of European soils and prevent flooding.

Finally, the use of compost contributes to counteracting the steady loss of soil organic matter across temperate regions.

Environmental impact of composting is mainly limited to some greenhouse gas emissions and volatile organic compounds. The impact on climate change due carbon sequestration is limited and mostly temporary. The agricultural benefits of compost use are evident but there is debate about their proper quantification (e.g. by comparison to other sources of soil improvers), while the main risk is soil pollution from bad quality compost. As bio-waste easily gets contaminated during mixed waste collection, its use on soil can lead to accumulation of hazardous substances in soil and plants. Typical contaminants of compost include heavy metals and impurities (e.g. broken glass), but there is also a potential risk of contamination by persistent organic substances such as PCDD/F, PCB or PAHs.

Proper control of input material coupled with the monitoring of compost quality is crucial. Only a few Member States allow compost production from mixed waste. Most require separate collection of bio-waste, often in the form of a positive list of waste which may be composted. This approach limits the risk and reduces the cost of compliance testing by allowing less extensive monitoring of production and use of compost.

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<sup>40</sup> AEA, 2001, Table A5.46, p.140.

<sup>41</sup> Brussels, 2001.

Home composting is sometimes regarded as the environmentally most beneficial way of handling domestic biodegradable waste, as it saves on transport emissions and costs, assures careful input control and increases the environmental awareness of the users.

As anaerobic digestion is conducted in closed reactors the emissions to the air are significantly lower and easier to control than from composting<sup>42</sup>. Every tonne of biowaste sent to biological treatment can deliver between 100-200 m<sup>3</sup> of biogas. Due to the energy recovery potential from biogas coupled with the soil improvement potential of residues (especially when treating separately collected biowaste) it may often represents the environmentally and economically most beneficial treatment technique<sup>43</sup>.

As most emissions from **Mechanical-Biological Treatment** operations result from biological treatment of biodegradable waste, the emissions into air are similar to composting or AD. However the end product is usually contaminated to a level which hinders its further use. Nevertheless, these techniques have the advantage of purifying the combustible fraction for incineration with energy recovery.

### Comparison of bio-waste management options

As the bio-waste is new concept in legislation – most studies refer to management of biodegradable waste. The difference is that bio-waste does not include paper and has higher moisture content, which may have impact especially for comparison of options including thermal treatment of waste.

For the management of biodegradable waste that is diverted from landfills, there seems to be no single environmentally best option. The environmental balance of the various options available for the management of this waste depends on a number of local factors, inter alia collection systems, waste composition and quality, climatic conditions, the potential of use of various waste derived products such as electricity, heat, methane-rich gas or compost. Therefore strategies for management of this waste should be determined at an appropriate scale based on a structured and comprehensive approach like Life Cycle Thinking (LCT) and the associated tool of Life Cycle Assessment (LCA)<sup>44</sup> to avoid overlooking relevant aspects and any bias.

The situation is of course dependant on the varying conditions in the countries. A range of Life Cycle Assessment (LCA) based studies have been conducted on national and regional scales<sup>45</sup>. Also recently, on behalf of the Commission, Life Cycle Assessments for MSW management in new member states have been conducted<sup>46</sup>.

Whilst arriving at different results depending on local conditions, they largely show the common pattern that the benefits of the chosen waste management system for biowaste significantly depend on:

- The amount of energy that can be recovered - is a crucial parameter, giving high energy efficient options a clear advantage. E.g. incineration may be justified in Denmark<sup>47</sup> while

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<sup>42</sup> Vito, 2007.

<sup>43</sup> JRC, 2007.

<sup>44</sup> See: <http://lca.jrc.ec.europa.eu/waste/>.

<sup>45</sup> JRC, 2007 and JRC, 2009.

<sup>46</sup> JRC, 2007.

<sup>47</sup> Copenhagen, 2007.

combined anaerobic digestion with composting of the digestate performs environmentally better than incineration with energy recovery in Malta<sup>48</sup>. It is due to better energy utilisation of wet biodegradable wastes by anaerobic digestion than by incineration.

- The source of the energy which is replaced by the recovered energy - if the replaced energy is mainly based on fossil fuels, the benefits of a high energy recovery of the biowaste system become more important. However, if the replaced energy is largely based on low emission sources, e.g. hydro energy, energy recovered from biowaste is obviously associated with significantly less environmental benefits.
- The amount, quality and use of the recycled compost and the products which are replaced by using compost - If the compost is used in landscaping or landfill cover any environmental benefits will be very limited. However, if high quality compost is replacing industrial fertilizers, the benefits usually will be significant<sup>49</sup>. Also the replacement of peat yields high environmental benefits.
- The emission profile of biological treatment plants - plants can have very different emission patterns which lead to more or less environmental impacts. The studies show especially importance of emissions of N<sub>2</sub>O and NH<sub>3</sub><sup>50</sup>.

The Commission is currently working on developing guidelines on the use of life-cycle thinking in biodegradable waste management<sup>51</sup>.

## 4.2. Economic impacts

The capital and operating costs of MSW management and biological treatment of waste depend on multiple factors and vary regionally and locally, hence it is difficult to arrive at meaningful average values or make comparisons. The most important variables for such costs include the plant's size, technology used, geological conditions (for landfills), costs of locally available energy, type of waste available, transport costs and others. This excludes indirect costs on the environment and health.

Landfilling is usually considered the cheapest option, especially if the price of land is low, or where the environmental costs of landfilling and future costs of landfill closure and aftercare have not yet been internalised in the gate fee (especially in the new Member States). The increase of costs due to the Landfill Directive will possibly change this situation combined with rising awareness of the “real” long term costs of landfills. Equally, revenues from energy recovery and products can at least partly offset the costs of other management options. These then can even come close to break even, making them economically more interesting than landfilling.

Incineration requires higher investment but can offer good economies of scale and does not require changes to existing MSW collection schemes for landfilling, while bringing in revenues from energy recovery especially when the efficiency is maximised by using waste in high efficiency cogeneration units for the production of both electricity and heat.

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<sup>48</sup> JRC, 2007.

<sup>49</sup> Heidelberg, 2002.

<sup>50</sup> JRC, 2007.

<sup>51</sup> <http://viso.jrc.ec.europa.eu/lca-biowaste> and <http://lca.jrc.ec.europa.eu/waste/>

With a diverse range of biological treatment technologies, it is more difficult to provide a single cost for such treatment and this will also depend on the market for the products. As biological treatment must be applied to waste of sufficient quality to deliver safe compost, the costs of separate collection of bio-waste must be added to the treatment process. Selling compost may be a source of additional revenues and again, energy recovery using anaerobic digestion can provide further revenues.

In the study for European Commission<sup>52</sup> the following financial cost estimates of management of biowaste were proposed as assumptions representative for the EU-15 (2002):

- Separate collection of bio-waste followed by composting: 35 to 75 €/tonne;
- Separate collection of bio-waste followed by anaerobic digestion: 80 to 125 €/tonne;
- Landfill of mixed waste: 55 €/tonne;
- Incineration of mixed waste: 90 €/tonne.

Eunomia estimates the additional costs of separate collection at 0-15 €/tonne, while optimisation of the separate collection systems (e.g. by increasing periods between collection of non-biodegradable waste) could decrease these costs below zero making collection profitable. On the other hand, COWI (2004) gives examples of much higher costs of separate collection of 37-135 €/tonne and estimates it possible to achieve net benefits of separate bio-waste collection, even if small and depending on a number of factors (cost of separate collection, energy efficiency of an alternative incinerator, type of energy displaced by energy from the alternative incinerator).

Investment costs of biological treatment plants vary, depending on the type of installation, the emission reduction techniques used, and the product quality requirements. Study supporting the Impact Assessment for the revision of IPPC directive quotes 60-150 €/tonne for open composting and 350-500 €/tonne for closed composting and digestion in large-scale installations<sup>53</sup>.

Market prices for compost are closely linked to the public perception and customer confidence in a product. Usually, compost for use in agriculture is sold for a symbolic price (e.g. 1 €/tonne, the price may even include transport and spreading). However, well marketed compost of recognised quality may reach 14 €/tonne, while for small amounts of packed compost or blends including compost the price may even reach 150-300 €/tonne. The prices are higher at well developed compost markets (see Chapter 3.2).

Due to high transport prices and low market value, compost is usually used close to the composting site and presently long-distance transport and international trade are limited which limits impact from the Internal Market on the competitiveness of this product.

There is no problem with the market for biogas or landfill gas. It can be burnt on site to generate heat and/or electricity or cleaned and upgraded to reach the quality of automotive fuel or natural gas pumped into the grid. These uses would maximise the potential of

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<sup>52</sup> Eunomia, 2002.

<sup>53</sup> Vito, 2007.

anaerobic digestion for reducing GHG emissions, helping to achieve both the Kyoto and the RES Directive's targets.

Separate collection schemes can help in diverting biodegradable waste from landfills, providing quality input to bio-waste recycling and improving the efficiency of energy recovery. However, setting up separate collection schemes is not without challenges, including:

- The need to re-design waste collection systems and change of citizens' habits. While properly designed separate collection systems are not necessarily more expensive<sup>54</sup>, their proper design and management require higher effort than mixed waste collection systems.
- Difficulties in identifying areas suitable for separate collection. In densely populated areas it is problematic to guarantee the necessary purity of the input. In scarcely populated areas separate collection may be too expensive and home composting may be a better solution.
- Problems of matching the waste arising with the use of recycled material – due to transport costs and low prices the use of compost is often confined to locations near the treatment plant. This may pose problems in densely populated areas.
- Hygiene and odour issues – especially in warm and hot climate.

#### **4.3. Social and health impacts**

Increased recycling of bio-waste is expected to have limited positive impacts on employment. New jobs may be created in waste collection and in small composting plants. Separate collection of bio-waste may be three times more labour-intensive than collecting mixed waste<sup>55</sup>. It is also likely that inhabitants of areas covered by separate collection will have to change their waste separation habits; however, there are no data for assessing the societal cost of separate collection.

There is a general lack of quality data on the health impacts of various waste management options based on epidemiologic studies. A study by DEFRA<sup>56</sup> did not reveal any apparent health effects for people living near MSW management facilities. Further to this study, in the future additional research could be required to ascertain the absence of risks to human health from such facilities. However, it identified small risks of birth defects in families living near landfill sites and of bronchitis and minor ailments for residents living nearby (especially open) composting plants though. No apparent health effects have been identified for incineration plants.

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<sup>54</sup> Optimized separate collection systems may substantially reduce the frequency of collection of residual waste, also savings on disposal may be considerable. See e.g. Favoino, 2002.

<sup>55</sup> Eunomia cited by COWI, 2004.

<sup>56</sup> DEFRA, 2004.

## **5. ISSUES FOR DISCUSSION**

### **5.1. Better prevention of waste**

The amount of bio-waste, although stabilized in recent years, has the potential to increase (especially in EU12)<sup>57</sup>. This may necessitate the strengthening of waste prevention policies. UK research<sup>58</sup> estimates that 6.7 million tonnes of food are wasted by households each year in the UK alone. Prevention of this waste could save at least 15 million tonnes of CO<sub>2</sub> equivalent emissions each year from disposal.

There are no easy administrative solutions however, as possible actions are generally linked to changing consumer behaviour and retail policies. Under the revised WFD, Member States will have to draw national prevention programmes, which will also address this issue. Moreover, the implementation of SCP/SIP Action Plan will also contribute to this objective<sup>59</sup>.

***Question 1: Waste prevention is at the top of the EU's waste treatment hierarchy. From your experience, what could be specific bio-waste prevention action at EU level?***

### **5.2. Limiting landfilling**

As discussed in Sections 3 and 4, landfilling of bio-waste is in general the least desirable waste management solution and should be minimized. Still, in many Member States increased implementation efforts and additional enforcement measures may be necessary for many years to fully implement the Landfill Directive.

It could therefore be useful to evaluate whether strengthening the current regulatory framework would bring additional environmental benefits. This could involve further action at EU level on the enforcement of the current provisions or, if necessary, strengthening the Directive. Equally, greater awareness of the alternatives and the associated revenues could promote a shift, especially if changes in infrastructure are financially supported.

***Question 2: Do you see benefits or disadvantages of further restricting the amount of biodegradable waste that is allowed on landfills beyond the targets already set in the EU Landfill Directive? If yes, should this be done on EU level or left to decide by Member States?***

### **5.3. Treatment options for biowaste diverted from landfill**

Once diverted from landfills, bio-waste can go through several treatment options as described in Sections 3 and 4. It is difficult to decide on the one single environmentally most beneficial bio-waste management option under all circumstances due to a large number of variables and local considerations that need to be taken into account. Management of diverted bio-waste should be addressed by additional measures supporting a move from simple pre-treatment for landfill and incineration with little or no energy recovery into incineration with high energy recovery, anaerobic digestion with biogas production and recycling of bio-waste. In addition to assessments to highlight the benefits, it could be further strengthened with targets for the maximum allowed amount of residual waste for disposal (landfilling or incineration without

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<sup>57</sup> EEA CSI-16.

<sup>58</sup> WRAP, 2008.

<sup>59</sup> COM(2008) 397.

energy recovery) or other measures in order to direct more bio-waste towards material and energy recovery.

***Question 3: Which options for the treatment of bio-waste diverted from landfills would you prefer to see strengthened and what would you see as their main benefits? Do you think that the choice of the treatment of bio-waste diverted from landfills should benefit from a wider and more consistent use of life-cycle assessment studies?***

#### **5.4. Improving energy recovery**

To help reach renewable energy targets, energy recovery could be significantly enhanced by developments in the area of anaerobic digestion for production of biogas and by improving the efficiency of waste incineration, for example by using cogeneration of electricity and heat.

Every tonne of bio-waste sent to biological treatment can deliver between 100-200 m<sup>3</sup> of biogas which could be upgraded to natural gas standards using 3-6% of its energy. Anaerobic digestion of mixed waste brings similar energy gains but makes further use of residues on land difficult.

Most of the energy gained via incineration of MSW results from burning highly calorific fractions such as paper, plastics, tyres, and synthetic textiles while the "wet fraction" of biodegradable waste reduces overall energy efficiency<sup>60</sup>. However, the biodegradable fraction of municipal waste (but including paper) still delivers about 50% of energy coming from an incineration plant and increased recycling of bio-waste could limit the amount of bio-waste available for incineration.

***Question 4: Do you think that energy recovery from bio-waste can make a valuable contribution to sustainable resource and waste management in the EU and meeting the EU's renewable energy targets in a sustainable way and, if so, under which conditions?***

#### **5.5. Increasing recycling**

As discussed in chapter 4 the recycling of bio-waste (e.g. compost being used on soil and for the production of growing media) can result in some environmental benefits, notably with regards to the improvement of carbon-depleted soils. In addition to assessments, new action to strengthen the recycling of bio-waste could therefore comprise three inter-related issues: recycling targets, rules for the quality and use of compost and supporting action in the shape of separate collection.

##### *5.5.1. Common bio-waste recycling targets*

In principle, such targets could be introduced either in separate bio-waste legislation or in the 2014 review of the recycling targets in the Waste Framework Directive. Due to differences between the Member States concerning demand for compost and energy, waste generation, population density, etc. it may be difficult or inappropriate to set a "one-size-fits-all" target while avoiding adverse environmental, economic and administrative effects and it might be necessary to leave room for national flexibility to identify the best waste management option for each situation.

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<sup>60</sup> AEA, 2001, Tables A3.36 and A3.37, p. 118.

### *5.5.2. National bio-waste recycling targets*

This option would be a variant of a general bio-waste recycling target set at Community level. Member States would be allowed to propose their national targets at the optimum level for each country taking into account the waste management hierarchy and Life Cycle Thinking. Such targets would act as drivers for the national stakeholders and set clear lines for national and regional bio-waste policies. There would however be a risk that targets are set at a low level of ambition. The possibility of setting national targets in EU legislation would also be reviewed.

### *5.5.3. Separate collection obligation*

Strengthening the supply of “clean” bio-waste could encourage investment in composting and biogas facilities. It would require organising national, regional or local separate collection of (selected) bio-waste possibly accompanied by targets for measuring progress requiring new reporting and enforcement obligations for waste managers and authorities, and thus create additional costs and administrative burdens for enterprises and public administrations, which should be considered in balance with environmental benefits.

***Question 5: Do you see a need for promoting bio-waste recycling (i.e. compost production or use on land of composted material) and, if so, how ? How can synergies be achieved between bio-waste recycling and energy recovery? Please provide the necessary evidence.***

## **5.6. Contributing to Soil Improvement**

As shown in detail in Section 4, bio-waste management could improve EU soils by delivering safe compost although the overall potential is limited (even a maximum increase of recycling of bio-waste across the EU could supply no more than 3.2% of agricultural land). Nevertheless, to avoid the risk of soil pollution and strengthen user confidence, it could be necessary to introduce common standards on bio-waste treatment and compost quality.

### *5.6.1. EU Standards for high-quality compost*

Setting common EU standards would clarify when material produced from bio-waste has completed the recovery process and can be regarded as a product rather than waste thus strengthening environmental and health protection and improving the market by increasing user confidence and facilitating cross-border trade. There are plans to set such standards in the near future under the Waste Framework Directive ("end-of-waste criteria").

### *5.6.2. EU Standards for treated bio-waste of lower quality*

Common EU rules could also be set for the use of treated bio-waste, such as low quality compost, which would remain subject to waste legislation, similarly to the requirements for spreading sewage sludge on agricultural land. Such rules could include quality criteria and total allowable load of heavy metals and other pollutants in compost and soil. "Waste composts" could be further sub-divided according to their potential application. "Compost" of even lower quality would have to be disposed of.

### *5.6.3. Rules set at national level*

As an alternative to EU common rules it could be required that Member States set national rules within a common framework, allowing them to adapt detailed rules in line with regional

or local considerations on environmental and health protection, and soil management choices. The downside of this approach would be continued uncertainty on the internal market, its likely fragmentation, complications for shipments, and administrative burden for operators. It could also jeopardise the realisation of the agreed policy goal of stronger recycling markets for a European Recycling Society.

**Question 6: In order to strengthen the use of compost/digestate:**

- *Should quality standards be set for compost as a product only or also for compost of lower quality still covered by the waste regime (e.g. for applications not linked to food production)?*
- *Should rules for the use of compost/digestate (e.g. limits on pollutant concentration in compost/digestate and land on which compost/digestate is applied) be set ?*
- *Which pollutants and concentrations should these standards be based on?*
- *What are the arguments for/against the use of compost (digestate) from mixed waste?*

#### 5.6.4. Operational (treatment) standards for small plants

Plants treating over 50 tonnes of bio-waste per day (most composting and digestion capacity) would be covered by the revised IPPC Directive. Covering plants treating below 50 tonnes was found disproportionate<sup>61</sup>. The relevant BAT Reference Document<sup>62</sup> covers anaerobic digestion and mechanical biological treatment, but not composting.

It will have to be decided whether composting plants which do not fall under the Animal By-Products Regulation should have to meet certain sanitation and monitoring requirements as a benchmark for licensing and to guarantee that compost used on land is safe.

**Question 7: Is there any evidence of gaps in the existing regulatory framework concerning the operational standards for plants which do not fall under the IPPC scope and if so, how should this be addressed?**

#### 5.7. Other uses of bio-waste

Many planned and ongoing research activities aim at developing alternative means of exploiting residual biomass and bio-waste to address the climate change issue and soil quality deterioration. Further bio-waste treatment options are being explored at research level (e.g. biochar)<sup>63</sup>.

**Question 8: What are the advantages and disadvantages of the abovementioned bio-waste management techniques? Do you see regulatory obstacle preventing the further developments and introduction of these techniques?**

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<sup>61</sup> Impact Assessment on the Proposal of Directive on Industrial Emission.

<sup>62</sup> BREF Waste Treatment.

<sup>63</sup> E.g. Fowles, 2007 and Lehmann, 2007.

Contributions to this consultation process should be sent to the Commission by 15 March 2009, by email to the address “ENV-BIOWASTE@ec.europa.eu”, or by post to the following address:

European Commission

Directorate-general Environment

Unit G.4 “Sustainable production and consumption”

B-1049 Brussels

This Green Paper will be published on the Commission’s website. The received contributions will be published, unless the author objects to publication of the personal data on the grounds that such publication would harm his or her legitimate interests. In this case the contribution may be published in anonymous form. Otherwise the contribution will not be published nor will, in principle, its content be taken into account.

Furthermore, since the launch in June 2008 of the Register for Interest Representatives (lobbyists) as part of the European Transparency Initiative, organisations are invited to use this Register to provide the Commission and the public at large with information about their objectives, funding and structures<sup>64</sup>. It is Commission policy that submissions will be considered as individual contributions, unless organisations register<sup>65</sup>.

In late 2009, the Commission intends to present its analysis of the responses received together with, if appropriate, its proposals and/or initiatives for an EU strategy on the management of bio-waste.

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<sup>64</sup> [www.ec.europa.eu/transparency/regrin](http://www.ec.europa.eu/transparency/regrin)

<sup>65</sup> COM(2007)127.