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FINAL REPORT

ASSESSMENT OF THE OPTIONS TO IMPROVE THE MANAGEMENT OF BIO-WASTE IN THE EUROPEAN UNION
ANNEX F: Environmental assumptions

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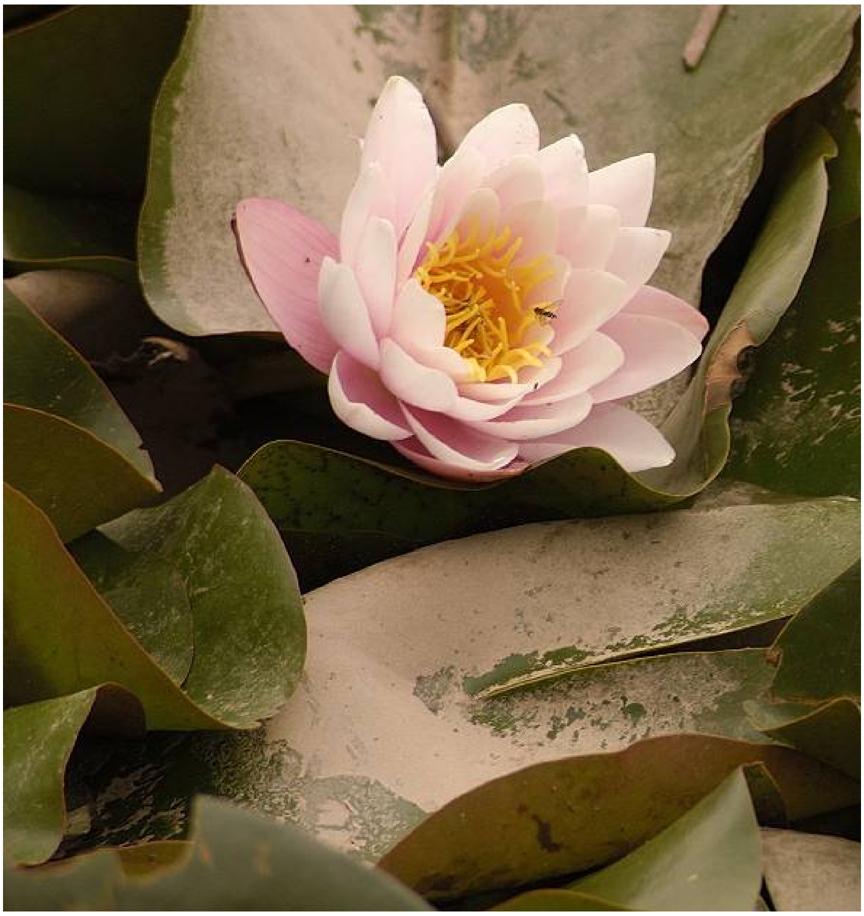

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ASSESSMENT OF THE OPTIONS TO IMPROVE THE MANAGEMENT OF BIO-WASTE IN THE EUROPEAN UNION

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A Generic Assumptions

A.1 Time

Time is an important factor when considering emissions modelling. Whilst incineration of biowaste results in an immediate release of CO_2, for example, composting biowaste with subsequent application to land results in at least partial sequestration of the organic carbon, with gradual release of CO_2 over an extended time period.[1]

If the overarching aim of any assessment is to determine the relative impacts of different technologies on climate change, and there is general consensus on the immediacy of the climate change issue, then the pace of release of greenhouse gases over time becomes an essential factor for consideration. In other words, the ability to sequester (or store) non-fossil carbon and effectively 'buy time' in terms of climate change is valuable. The importance of time-limited carbon sequestration was highlighted to the EU in a report by AEA Technology:[2]

> *However, for almost all treatment options, not all of the carbon released from organic materials during the treatment process is returned to the atmosphere; some remains in the 'residue' from the treatment process. This raises the issue of how this carbon should be accounted for, when comparing the treatment options in terms of climate change. If the carbon is sequestered in a form which is unavailable to the natural carbon cycle over a sufficiently long time period, then it could be argued that a 'sink' for carbon has been created and the treatment options should receive a carbon credit for this. The two main routes for carbon storage in waste management are in landfills (where the anaerobic conditions inhibit the decomposition of certain types of waste, particularly woody materials) and in compost applied to soil (where a proportion of the carbon becomes converted to very stable humic substances which can persist for hundreds of years). The permanency of such sinks is difficult to assess, and depends on the time scale used to define permanent. Available data suggests that 'woody' type materials in landfill may have only partially degraded over a one hundred year time scale, but degradation rates over a 500 year period are not known*.

LCA studies typically define a moment in time and aggregate all emissions occurring until that point in time. Such analyses have been criticised as not being a reliable indicator of the contribution of waste treatments to climate change because they ignore, to a certain degree, the dimension of time.[3]

For processes whose profile of emissions varies in time, this raises the following questions:

- Do emissions in all years count equally, or should a form of discounting be applied in such analyses? and;
- What is the justification for drawing the cut off in time in one year as opposed to another?

[1] G. Finnveden, J. Johansson, P. Lind and A. Moberg (2000) *Life Cycle Assessments of Energy from Solid Waste*, FMS: Stockholm

[2] AEA (2001) *Waste Management Options and Climate Change – Final report to the European Commission, DG Environment*

[3] Eunomia (2006) A Changing Climate for Energy from Waste? Final Report for Friends of the Earth, April 2006

In other words, 'doesn't time matter?' Given the discussion presented above regarding time-limited sequestration of non-fossil carbon, time evidently does matter, or at least should be considered in a comprehensive analysis.

Approach Taken in the Current Study

For the purposes of the present study we have applied the declining discount rate proposed by the UK's HM Treasury Green Book, as presented in Table A-1. The Green Book recommends using a discount rate of 3.5%. However, for projects with impacts exceeding thirty years, it recommends that a declining schedule of discount rates should be used rather a single, constant discount rate.

Table A-1: The declining long-term discount rate, as recommended in the Treasury Green Book

Period of years	0-30	31-75	76-125	126-200	201-300	301+
Discount rate	3.5%	3.0%	2.5%	2.0%	1.5%	1.0%

A.2 Biogenic CO_2 Emissions

A key issue in the assessment of GHG emissions from waste treatment technologies is whether or not non-fossil CO_2 (otherwise known as biogenic CO_2) should be included.

Under international GHG accounting methods developed by the Intergovernmental Panel on Climate Change (IPCC), non-fossil CO_2 is considered to be part of the natural carbon balance and therefore not a contributor to atmospheric concentrations of CO_2.[4] The rationale behind the IPCC's decision is that non-fossil carbon was originally removed from the atmosphere via photosynthesis, and under natural conditions, it would eventually cycle back to the atmosphere as CO_2 due to degradation processes. Climate change, however, is attributed to anthropogenic emissions, which impact this natural carbon cycle.

As regards waste, the Guidelines from IPCC state that the following should be reported: [5]

> *Total emissions from solid waste disposal on land, wastewater, waste incineration and any other waste management activity. Any CO_2 emissions from fossil-based products (incineration or decomposition) should be accounted for here but see note on double counting under Section 2 "Reporting the National Inventory." CO_2 from organic waste handling and decay should not be included.*

Specifically regarding waste incineration, the same guidelines state that reporting should include:

> *Incineration of waste, not including waste-to-energy facilities. Emissions from waste burnt for energy are reported under the Energy Module, 1 A. Emissions from burning of agricultural wastes should be reported under Section 4. All non-CO_2 greenhouse gases from incineration should be reported here as well as CO_2 from non-biological waste.*

Given the above, then it is worth reporting what is set out regarding energy. The following are to be reported:

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[4] Intergovernmental Panel on Climate Change. *Greenhouse Gas Inventory Reference Manual: Revised 1996 IPCC Guidelines for National Greenhouse Gas Inventories*, Vol. 3, Pg. 6.28, (Paris France 1997).

[5] Understanding the Common Reporting Framework, in IPCC (u.d.) Revised 1996 IPCC Reporting Guidelines for National Greenhouse Gas Inventories, Reporting Instructions (Volume 1), Hadley Centre, Bracknell

Total emissions of all greenhouse gases from all fuel combustion activities as described further below. CO_2 emissions from combustion of biomass fuels are not included in totals for the energy sector. They may not be net emissions if the biomass is sustainably produced. If biomass is harvested at an unsustainable rate (that is, faster than annual regrowth), net CO_2 emissions will appear as a loss of biomass stocks in the Land-Use Change and Forestry module. Other greenhouse gases from biomass fuel combustion are considered net emissions and are reported under Energy. (Sum of I A 1 to I A 5). Incineration of waste for waste-to-energy facilities should be reported here and not under Section 6C. Emissions based upon fuel for use on ships or aircraft engaged in international transport (1 A 3 a i and 1 A 3 d i) should, as far as possible, not be included in national totals but reported separately.

Methane (CH_4) is also derived primarily from non-fossil carbon during degradation processes. However, CH_4 emissions from landfills are counted within GHG inventories. The rationale provided by the IPCC can be described as follows:[6]

CH_4 emissions from landfills are counted - even though the source of carbon is primarily biogenic, CH_4 would not be emitted were it not for the human activity of landfilling the waste, which creates anaerobic conditions conducive to CH_4 formation.

Currently, convention appears to be shaped by IPCC's approach to dealing with non-fossil carbon in the reporting of Greenhouse Gas Inventories by different countries.

The crucial point here is that for the purposes of IPCC reporting, non-fossil CO_2 from incineration is effectively not reported – an approach also recommended by the French waste management industry.[7] Although it could be argued that this convention of ignoring non-fossil CO_2 is appropriate within the inventory context, it has perhaps erroneously been applied to comparative assessments between waste management processes.[8]

Whatever the merits or otherwise of not reporting biogenic CO_2 for the purpose of national inventories, in comparative assessments between processes, it cannot be valid to ignore biogenic CO_2 if the different processes deal with biogenic CO_2 in different ways. Given that different processes often deal with non-fossil CO_2 in different ways, and that the atmosphere does not distinguish between molecules of greenhouse gas depending on their origin, the omission of non-fossil CO_2 from analyses appears dubious. The need to include biogenic CO_2 is well recognized by some of those involved in life-cycle assessments, such as Finnveden *et al*.:[9]

The practise to disregard biotic CO_2-emissions can lead to erroneous results (Dobson 1998). Let us consider an example to illustrate this. Let us compare incineration and landfilling of a hypothetical product consisting of only cellulose. When incinerated, nearly 100 % of the carbon is emitted as CO_2. However, in the inventory, this emission is often disregarded as noted above. If the product is landfilled, approximately 70 % of the material is expected to be degraded and emitted during a short time period, mainly as CO_2 and CH_4 (Finnveden et al. 1995) (The short time period is here defined as the surveyable time period). Again the

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6 USEPA (2004) *Greenhouse Gas Emission Factors for Municipal Waste Combustion and Other Practices*

7 L'Entreprises pour L'Environnement, *Protocol for the quantification of greenhouse gas emissions from waste management activities*, September 2006, Nanterre, France

8 For example, ERM (2006) *Carbon Balances and Energy Impacts of the Management of UK Wastes*, Final Report for Defra, December 2006

9 G. Finnveden, J. Johansson, P. Lind and A. Moberg (2000) *Life Cycle Assessments of Energy from Solid Waste*, FMS: Stockholm

emitted CO_2 is normally disregarded, although the CH_4-emissions are noted. During the surveyable time period, 30 % of the carbon is expected to be trapped in the landfill. There is thus a difference between the landfilling and the incineration alternatives in this respect, in the incineration case all carbon is emitted, whereas in the landfilling case some of the carbon is trapped. This difference is however not noted, since the CO_2-emissions are disregarded and this is in principle a mistake. Additionally, the biological carbon emitted as CH_4 in the landfilling case is noted and will discredit this option. It could be argued that a part of the global warming potential, corresponding to the potential of the same amount of biological carbon in CO_2, should be subtracted from the landfilling inventory.

Recent articles published in both the International Journal of Life Cycle Assessment and Science also recommend the same approach as that taken by Finnveden et al.[10]

The IPCC Guideline regarding emissions related to energy requires further analysis in the context of refuse-derived fuels (RDF). If the biomass portion of RDF is included under the definition of 'biomass fuels', then whether or not CO_2 emissions should be included (for inventory purposes) would appear to depend on the sustainability of the production of that biomass. Considering the heterogeneous mix of biological material contributing to the biomass portion of waste, the task of determining what is or is not sustainably produced would be extremely difficult. Should a comparison of the GHG intensity of waste management processes relative to traditional fossil fuel generation be undertaken, this might be a worthy approach.

In the IPCC Guidelines, in theory, this would not be of significance if one was confident that the reporting of inventories under the Agriculture, Forestry and Other Land Use (AFOLU) Section took adequate account of all the effects of waste-related activities on changes in soil carbon, carbon in the existing forest stock, etc. Using, as a convention, the assumption that the non-fossil CO_2 is unimportant risks, however, ignoring the matter of the potential significance of changing the rate of flux of CO_2 from non-fossil sources into the atmosphere. Clearly, burning biomass leads to the immediate release of CO_2. However, composting biomass leads to the production of compost which, on application to soil, increases the carbon stock, and releases the carbon over an extended period of time.[11]

Approach Taken in the Current Study

The current study includes all biogenic CO_2 emissions from waste management processes. Our approach to the biogenic CO_2 emissions resulting from wood combustion (where wood is used as a renewable energy source) is discussed in Section A.4.4.2.

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[10] See, for example: Rabl A, Benoist A, Dron D, Peuportier B, Spadaro J V and Zoughaib A (2007) How to Account for CO_2 Emissions from Biomass in an LCA, *Int J LCA*, 12(5) p 281; Searchinger T D, Hamburg S P, Melillo J, Chameides W, Havlik P, Kammen D M, Likens G E, Lubowski R N, Obersteiner M, Oppenheimer M, Robertson G P, Schlesinger W H and Tilman G D (2009) Fixing a Critical Climate Accounting Error, *Science*, 326, pp527-528

[11] See E. Favoino and D. Hogg (2008) The Potential Role of Compost in Reducing Greenhouse Gases, *Waste Management Research,* 2008; pp. 26; 61