Key Issue Paper

ISWA
International Solid Waste Association

Biodegradable Plastics

An Overview of the Compostability of Biodegradable Plastics and its Implications for the Collection and Treatment of Organic Wastes

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ISWA– the International Solid Waste Association
is a global, independent and non-profit making association, working in the public interest to promote and develop sustainable and professional waste management worldwide

Prepared for ISWA by the Working Group on Biological Treatment of Waste

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Executive summary

Plastic waste is produced across the world; in the EU[1] about 25 million tonnes is produced annually while in the USA[2] over 30 million tonnes is generated every year. Although plastics are made into an array of important products offering significant consumer benefits, they can also litter the environment and harm ecosystems; notably, plastic waste constitutes the majority of ocean debris. In response to this the plastics industry is offering the market new types of biodegradable polymers that are viewed by many as providing more 'environmentally friendly' alternatives to traditional polymers; however, there is a confusing array of terminologies and associated polymer properties. This paper therefore aims to provide an overview of the different types of biodegradable plastics, their properties and their role in the management of organic wastes.

In Chapter 2 the key terms referring to conventional and biodegradable plastics are briefly defined in order to provide a common understanding of the fundamental aspects involving compostability of plastic polymers and renewable (bio-based) content.

Chapter 3 describes the advantages and disadvantages of biodegradable plastics compared to traditional, fossil-based and non-degradable polymers, whilst Chapter 4 outlines a number of initiatives to promote the use of biodegradable plastics. Most of these refer to the use of compostable bags and carrier bags (shoppers) used either in conjunction with separate organic waste collection schemes or to reduce the impact of littering.

Chapter 5 links the topic of biodegradable plastics with the possibilities of treating and recycling these polymers in biological treatment plants, i.e. composting and anaerobic digestion, highlighting that only some types of biodegradable plastics are also 'compostable' and that testing and certification of compostable plastic can enhance its use and raise awareness among consumers.

Certification standards for compostable plastics are summarised in Chapter 6, which highlights that they are established to ensure total biodegradability within industrial processes. The comparison between different certification standards shows that there are still significant differences among specific standards, although an international specification for compostable plastics (ISO 17088) already exists. Certification labels enable consumers to distinguish biodegradable plastics from conventional plastics, whilst also facilitating organic waste collection and recycling programmes in biological treatment plants.

The current status about the use of biodegradable plastics in organic waste recycling is summarised in Chapter 7, quoting examples across the EU, USA, Canada and Brazil.

Finally, Chapter 8 summarises a short survey carried out by the ISWA Working Group on Biological Treatment about the status of biodegradable plastics in organic waste collection and treatment in some EU countries, North America and Japan. It illustrates that the use of compostable plastic and paper bags for organic waste collection and treatment processes is a proven technique in many countries that have a developed sector for organic waste recycling.

The ISWA Working Group concludes that there is a need for biodegradable plastics to be clearly labelled, so to enhance consumer awareness and help distinguish compostable plastics from other non-compostable polymers. There is the possibility to develop a globally recognised label based on the ISO standard.

1 Plastic Waste: Ecological and Human Health Impacts, DG Environment News Alert Service, 2011
2 http://www3.epa.gov/epawaste/nonhaz/municipal/pubs/2012_msw_dat_tbls.pdf [Accessed 17 June 2015]

1. Introduction

The ISWA Working Group on Biological Treatment of Waste (WGBTW) addresses the collection, treatment and end use of the organic fraction of solid wastes. This includes both established aerobic processes (such as composting) and anaerobic processes (such as anaerobic digestion), as well as a range of emerging and related technologies (such as aerobic digestion).

This paper was produced by the members of the WGBTW. It aims to provide an overview of the different types of biodegradable plastics, their properties and their role in the management of organic[3] wastes. It specifically focusses on composting and anaerobic digestion processes.

The detrimental impacts of plastic wastes on land and water ecosystems have been well documented in recent years in both the scientific and popular press. Most plastic wastes are released into the environment every year, presenting multiple risks to fauna and, ultimately, to human health.

Notably, every year, millions of tonnes of litter end up in the oceans worldwide, turning it into the world's biggest landfill. This has significant negative effects on marine biodiversity, on the economic potential in the tourism and fisheries sectors, and on the benefits of coastal populations. Land-based sources account for up to 80% of marine litter and are particularly a result of sewer overflows, lack of public awareness, inappropriate waste management collection and treatment infrastructure, and tourism related littering[4].

As plastics degrade they fragment in the environment, breaking up into smaller pieces. Microscopic particles of common polymers (so-called micro-plastics) are now present on shorelines and in the water column throughout the North East Atlantic Ocean. Pieces as small as 2 µm have been reported and the abundance of such fragments has increased significantly over the last 40 years. Within Europe the policy initiative 'Towards a circular economy: A zero waste programme for Europe' includes proposals for revising waste legislation and for an aspirational target to reduce marine litter by 30% by 2020[5].

Low-cost conventional plastic products therefore do not reflect the total cost of their environmental burden[6]. Biodegradable plastics are viewed by many as providing more 'environmentally friendly' alternatives to these traditional (non-biodegradable) plastic polymers; however, they too have both advantages and disadvantages. This paper explores some of these issues, using background information supplied by ISWA members and experts in selected countries.

The information in this paper was correct as of September 2015.

2. Definitions

There is a confusing array of terminology associated with biodegradable plastics. Words such as 'bio', 'degradable' or 'compostable' are often used interchangeably, despite having different technical meanings, which impact upon the way the polymer can be used, recycled or disposed of. The key terms are defined below.

2.1 Biodegradable plastics

A biodegradable plastic is a plastic that can be broken down into its constituent monomers and metabo-

3 Within the context of this document, 'organic wastes' includes bio-wastes defined in the EU Waste Framework Directive 2008/98/EC (biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises and comparable waste from food processing plants), as well as other wastes, similar in nature to bio-wastes. For consistency, they are referred to as 'organic wastes' within this paper.
4 Working paper on Marine Litter; Sweepnet 2014
5 http://ec.europa.eu/environment/marine/good-environmental-status/descriptor-10/index_en.htm
6 Green Paper on "EU Strategy on Plastic Waste in the Environment", COM(2013)123 final, 2013.

lised through the action of naturally occurring micro-organisms, such as bacteria and fungi, over a period of time. Biodegradation refers to biochemical processes during which naturally occurring micro-organisms in the environment, convert the polymer into substances such as water, carbon dioxide and biomass.

Some biodegradable plastics may be broken down quickly, whilst others take longer. The rate of biodegradation is largely dependent upon the composition and thickness of the material, as well as environmental conditions to which it is exposed. This means that a plastic classed as biodegradable may not necessarily be suitable for recycling in a composting or anaerobic digestion (AD) plant, if it takes too long to biodegrade.

The packaging industry (manufacturing, for example, packets, films and bags) represents the market sector with largest growth potential for biodegradable plastics in the near future[7].

2.2 Compostable plastics

A compostable plastic is one that is 'capable of undergoing biological decomposition in a compost site as part of an available programme, such that the plastic is not visually distinguishable and breaks down to carbon dioxide, water, inorganic compounds, and biomass, at a rate consistent with known compostable materials (e.g. cellulose), and leaves no toxic residue'[8]. In practice, this means that plastics classed as 'compostable' need to be able to undergo biodegradation during the course of a typical composting process, and not adversely affect the quality of the resultant compost. This is discussed further in the following chapter.

Currently, there are a number of different compostable plastics available on the market. The most commonly used raw material for making compostable plastics is corn starch, which is converted into a polymer with similar properties to traditional polyethylene plastic products. Other compostable plastics are available made from potato starch, soybean protein, cellulose and as well from petroleum and petroleum by-products. This means that compostable plastics may be derived from both plant-based and petroleum-derived polymers.

The field of compostable plastics is constantly evolving with new materials and technologies being developed and brought to market.

2.3 Bioplastics or bio-based plastics

Bioplastics are those that are derived from plant-based polymers, such as corn starch, sugarcane or cellulose, and are not derived from petroleum resources. They may also be referred to as 'bio-based' polymers.

There are a number of different types of bio-plastics: some are biodegradable, some compostable, whilst others exhibit properties more usually associated with conventional plastics, and are not biodegradable.

Biodegradability is an add-on property of certain types of bioplastics, since it offers an additional recovery option at the end of a product's life. The biodegradation property depends on its chemical structure and not upon the source of the polymer. This means that not all bioplastics are biodegradable.

The distinction between bioplastics and biodegradability is shown in Figure 1.

7 http://www.bioplasticsmagazine.com/en/news/meldungen/New-market-report.php
8 American Society for Testing & Materials D6400-04, Standard Specification for Compostable Plastics.

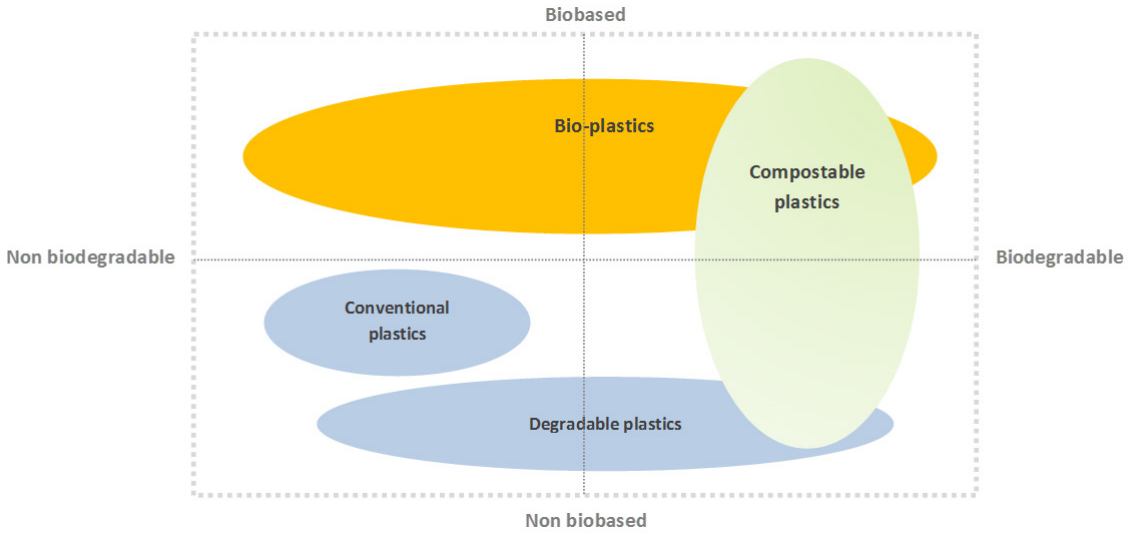


Figure 1: Plastics material co-ordinate system. Source: Based on: European Bioplastics fact sheet.

2.4 Degradable plastics

Degradable plastics are those that undergo significant changes in their physical structure under specific environmental conditions resulting in loss of structural properties. Degradable plastics generally disintegrate into smaller fragments; however, these fragments may, or may not, be biodegradable, depending upon the polymer type. Most degradable plastics are made out of polyethylene and contain an additive to speed up disintegration. (This is discussed further in the following section on oxo-degradable polymers).

3. Advantages and disadvantages of biodegradable plastics

3.1 Advantages of biodegradable plastics

Biodegradable plastics can reduce some of the environmental problems resulting from the uncontrolled disposal of plastic wastes. They are particularly suited to recycling alongside organic wastes, as long as the plastics are 'compostable'.

We can assume that biodegradable plastics are best used to substitute conventional plastics that generate environmental problems either during use or at their end-of-life. Typical examples are improperly disposed of shopping bags, which can be harmful for sea life, or when conventional plastics packaging becomes contaminated by food, thus making it more difficult to recycle.

Compostable plastic bags are also useful in the separate collection of food wastes from households and businesses. These bags can be fully embedded in composting (i.e. material recycling) processes, without causing any negative effect on the compost produced. This is discussed further below in Section 7.

3.2 Advantages of bio-based biodegradable plastics

The main advantage of bio-based plastic products compared to conventional plastics, is that they negate the use of fossil resources by using biomass. In theory, this biomass provides potential for carbon neutrality, contributing to a reduction in greenhouse gas emissions. They can contribute to improved resource

efficiency through biomass use cascades, as they are suitable for recycling and energy recovery after any possible reuse and recycling option. Secondly, they can avoid some of the environmental problems resulting from uncontrolled land spreading and disposal at sea.

The increasing use of biodegradable plastics means that there is more interest in using bio-based (renewable) resources to manufacture these products, however, there are currently no regulations that require plastics manufacturers to declare the presence of renewable resources within a product. Notwithstanding, there is a European test method[9], which specifies a calculation method for determining the bio-based carbon content in monomers, polymers and plastic materials and products, based on ^{14}C content measurement. It is currently the most important guideline for substantiating marketing claims regarding a material or product's bio-based carbon content.

3.3 Disadvantages

Despite the many significant advantages of biodegradable polymers there are also a number of disadvantages that need to be taken into account.

Firstly, like any product, its uncontrolled disposal can lead to littering and pollution of the soil or water courses. Although by their very nature, biodegradable polymers will be broken down naturally, there remains the potential for harm to wildlife when a product is initially discarded.

As many biodegradable polymers are functionally similar to their conventional counterparts, clear labelling, disposal and recycling instructions are needed to prevent these polymers 'contaminating' conventional plastics recycling processes.

In the event that compostable plastics do end up in regular plastic recycling streams, sorting technologies are able to remove them effectively (for example, polylactic acid polymers can be removed from a mixed plastics stream[10]). In those instances where residual amounts of compostable plastics remain, studies have shown that they are similarly or more easily handled compared with conventional contaminating plastic polymers in a polyethylene (PE) stream. They are not thought to add significantly to the cost or complexity of recycling processes or the recovery of valuable, recycled PE[11]. This remains true up to 10% compostable plastic films in the waste stream; at this level or below, studies[12] show negligible impact on the technical performance of recycled PE. Another study[13], focusing on recycling of PE, showed that the contaminating effect of a compostable plastic on PE is less than the contaminating effect of polyethylene terephthalate (PET).

Disposal in landfill of biodegradable polymers may also contribute towards the biodegradability of landfilled wastes, which, in turn, can impact upon methane generation and potential release into the atmosphere.

Finally, the growth of crops to manufacture plastics can be viewed as creating competition for land on which to grow food. This argument has been widely debated in recent years with regard to crops grown for fuels (the 'fuels versus food' debate). According to the European Bioplastic Association[14] there is currently no competition between renewable materials and crops used for producing bio-plastics, which amounts 0.006% of the global agricultural area (GAA) and is forecast, due to expansion of the bioplastics

9 CEN/TS 16137:2011 Plastics – Determination of bio-based carbon content
10 NIR systems can be applied to sort PLA from mixed plastics, Domestic Mixed Plastics Packaging Waste Management Options, WRAP 2008
11 The Behaviour of Bioplastic Films In Mechanical Recycling Streams; Meta Study, European Bioplastics
12 Studies by the University of Hannover [1], [2] examined the influence of different compostable plastic films on low-density polyethylene (LDPE): A. Kitzler, Bioplastics in Waste Management Streams, Dissertation, University of Hannover, 2013; H.-J. Endres, A.-A. de la Cruz, Influence of PLA/PBAT material (ecovio) on the recycling of conventional LD PE, University of Hannover, 2013
13 C. Heß, Influence of BIOPLAST-Material and conventional non-PE Plastics on the mechanical Properties of recycled PE-Film, BIOTEC, Presented at K Fair 2013
14 FAQ of the European Bioplastic Association, 2013.

sector, to increase to 1% of the GAA. This amount is negligible compared to the GAA used for feedstock production for animal feeding[15].

4. Promoting the Use of Biodegradable Plastics

Currently there are a number of different initiatives worldwide aimed at reducing the use of single use carrier bags made out of petrol-derived plastics by promoting the use of reusable or biodegradable and compostable plastics. These are shown in Figure 2.

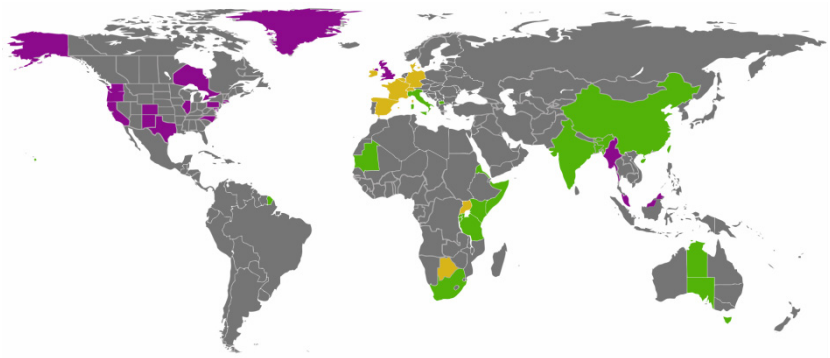


Figure 2: Phase out of lightweight plastic bags around the world. Green for Plastic bags banned; Orange for A tax on some plastic bags; Purple for Partial tax or ban (municipal or regional levels)

A clear example of legislative instrument was issued in April 2015 by the European Parliament, amending the EU Packaging and Packaging Waste Directive (PPWD) with the aim of reducing the use of conventional single use plastic carrier bags. This new legislation obliges EU Member States to introduce measures that reduce the use of lightweight plastic bags by almost 50% by the end of 2019 and by 80% by the end of 2025 compared to 2010.

The following Table 1 summarises some of the different policy instruments that can be introduced to promote reduction in use of conventional plastics and promote the use of biodegradable, and in particular compostable, plastics.

Table 1: Policy instruments to promote the use of biodegradable plastics

Type of instrument	Instrument	Application	Relevant examples
Communication	Distribution of a kit of compostable bags along with communication campaigns for food waste collection	When introducing new collection schemes, then annual delivery	Italy, Spain (Catalonia, Basque country), UK, Norway, parts of Canada
Economic	Centralised purchases by local authorities / councils to provide bags to citizens at a cheap price (subsidized), or at the purchase price (cheaper than supermarket price), or including the price in the waste collection tax	Periodical distribution to households, by means of municipal delivery points, vending machines, local shops	See above
Legal	Ban on the use of plastic carrier bags in shops, only reusable or compostable bags allowed	To promote the secondary use of carrier bags as a tool for food waste collection after their primary use	Italy
	Ban on use of shopping plastics bags, substitution with other types of bags (paper, reusable)	There are many examples across the world on plastic bag bans, few specify the exemption on compostable bags (Italy)	See Figure 2
	Ban on the use of non-compostable bags used for waste collection by municipality	Separate collection of biowaste	Italy, Seattle, Niagara Region, Norway, UK

15 GAA used for feedstock is estimated at 10-12%. See Page 17: http://www.miljo.lth.se/svenska/internt/publikationer_internt/pdf-filer/Challenges%20and%20opportunities%20for%20future%20production%20of%20food%20feed%20and%20biofuel.pdf

Type of instrument	Instrument	Application	Relevant examples
Legal & Economic	Landfill tax –return scheme including return criteria to municipalities based on the use of compostable bags for biowaste collection	Where a return systems is defined in order to improve the quantity and quality (reduce impurities, especially conventional plastic bags) in organic waste collections	Catalonia (Spain) Sardinia (Italy)
Economic & Communication	Authorities' subsidies for deploying municipal communication campaigns for the introduction and improvement food waste collection and acquisition and distribution of kits including vented caddies and compostable bags		Catalonia (Spain)

5. Use of Biodegradable Plastics in Biological Treatment Plants

5.1 Biological treatment of waste

Biological treatment techniques may be either aerobic (such as composting) or anaerobic (such as anaerobic digestion)[16].

Composting

Composting of separately collected feedstock represents (in EU member states, the USA and Canada) the most widely applied recycling process for separately collected organic waste, both in terms of the number of plants and annual capacity.

In the EU, organics recycling is driven primarily by the Landfill Directive (1999/31/EC), which obliges Member States to reduce the amount of biodegradable municipal waste that they landfill, and by the Waste Framework Directive (WFD, 2008/98/EC) which mandates Member States to take measures to encourage the separate collection of bio-waste with a view to composting and digestion in a way that ensures a high level of environmental protection. This means that plastic residues remaining in compost threaten the quality of the product, thereby reducing its effectiveness to be applied to soils.

Anaerobic digestion

The use of anaerobic digestion to treat biowaste both from separate collection schemes and from mechanical treatment of mixed municipal solid waste is growing. The digestion process produces biogas, a renewable source of energy, a digestate which can be composted or applied to soils directly as a biofertilizer.

Mechanical Biological Treatment (MBT)

This represents an effective technique for treating unsorted wastes to reduce its biodegradable content. It therefore prevents or reduces biodegradable organics being landfilled, which would otherwise generate methane emissions and leachate.

5.2 Types of biodegradable plastics suitable for composting

Of the three groups of the plastics family outlined in Figure 1, only two are biodegradable and – under specific treatment conditions – can be compostable; these groups are:

1) Bio-based and biodegradable plastics; and

16 A short description about recycling techniques for biowaste can be found in the ISWA key Issue Paper "Food Waste As a Global Issue"

2) Biodegradable plastics based on fossil resources.

As noted previously, 'biodegradable' has a different meaning from 'compostable'. A compostable plastic means that the materials biodegrade under specific conditions and within a fixed time frame, thus they can be recycled in industrial composting plants. These conditions are specified in a variety of internationally recognised standards and is discussed in more detail in Section 6.3.

5.3 Using compostable plastics in simple, small-scale composting facilities

Small-scale composting processes are often similar to those used in large industrial plants. However, it is important to apply the following management protocols to ensure the adequate biodegradation of the bags during the process:

- It is recommended that the bags be opened and torn immediately prior to composting to ensure that the compostable plastics are reduced in size and mixed with the bulking material to ensure that the process conditions are optimal. This may be achieved by using a windrow turning machine, a dedicated mixing machine, or even a livestock feed-mixer or a manure spreader.
- Where it is not possible to open bags prior to processing, biodegradation can be slower and some precautions need to be applied to minimize possible processing problems. It is recommended that all bags at the surface of the windrow be covered with additional bulking material, and ensure that moisture levels are maintained. Keeping the bags covered and maintaining adequate moisture levels of the mass at all times are key factors.

Additionally, the use of compostable bags certified as suitable for 'home composting' (see Section 6.3) can be beneficial.

5.4 Using compostable plastics in home (backyard) composting units

When using bioplastic bags in small scale home or community composting units, the following recommendation should be considered:

- It is best to use compostable bags certified specifically for home composting processes, as these have been tested under conditions better suited to low-temperature systems.
- Ensure that bags do not remain closed and are not stacked up one on top of another inside the composter. Where this happens, degradation of the bags and the inner organic material will be slower as air will not circulate optimally. Should this occur, turning the composting mass or using an aeration tool can help. This will also help perforate and tear the bag so that the fragments can be more easily degraded.
- Another option is to deposit the contents of the bag directly into the composter, then place the empty bag in the unit on its own.
- Finally, by taking care to ensure that moisture levels are maintained and the contents are turned periodically, this should aid biodegradation.

5.5 Using compostable bags in anaerobic digestion units

Starch based compostable bags can be effectively biodegraded inside anaerobic digestion units provided that they are adequately pre-treated before entering the digester. Problems have arisen at low solids – high liquid AD plants where intact bags can become entangled around pumps and mixing equipment. Fragments of bags can also remain in the resultant digestate, which can contaminate this product if it is applied to land directly (without any post aerobic treatment).

To overcome these problems, specific pre-treatment of incoming feedstocks through either a screw or centrifugal press can help macerate the bags and partially solubilise the polymer, or they can be removed prior to digestions. This is discussed further in Section 7.

5.6 Oxo-degradable plastics and composting

Oxo-degradable plastics are made of conventional petroleum-based polymers (such as polyethylene (PE), polypropylene (PP), polystyrene (PS), polyethylene terephtalate (PET) and sometimes also polyvinylchloride (PVC)) to which an additive has been added (usually a transition metal compound), that accelerates their degradation when exposed to heat and/or light. The 'oxo-biodegradable' additives are typically incorporated into these conventional plastics as at the moment of conversion into final products. As they disintegrate at a faster rate than conventional plastics, there is some confusion about their role in the collection and treatment of bio-waste.

A comprehensive study[17] by the English Department for Environment, Food and Rural Affairs (DEFRA) showed that oxo-degradable plastics do not meet established composting standards, such as the EN13432. It found that it is 'unclear how long it takes for oxo-degradable plastics to biodegrade, or whether they biodegrade completely'[18]. As such, it would be unwise to dispose of oxo-degradable plastics in home composting or industrial composting facilities. The study also concluded that 'The fate of oxo-degradable plastic after it has fragmented to a fine powder is not clear'. The authors also noted that: 'it is recommended that further research is carried out to determine whether complete degradation to carbon dioxide and water is achieved, and if so, over what time scale. If the fine particles are found to persist in the environment for a long period of time, the potential for harm is such that research should be carried out to determine the effect of the particles on plants, invertebrates and animals.' The study also recommended that oxo-degradable plastics should not be recycled with conventional plastics due to the potential for the additives to contaminate the recycling system, and weaken the recycled product. Whilst finalizing this ISWA document, a new study on the 'Evaluation of Biodegradation-Promoting Additives for Plastics' conducted at Michigan State University found no evidence that any of the biodegradation promoting additives tested (including those that promote oxo-fragmentation) promoted and/or enhanced biodegradation of PE or PET polymers[19].

The term 'oxo-biodegradable' is an appealing marketing term which may, however, be misleading. The U.S. Federal Trade Commission has advised[20] companies 'that unqualified biodegradable claims are acceptable only if they have scientific evidence that their product will completely decompose within a reasonably short period of time under customary methods of disposal.' Accordingly, the National Advertising Division in the USA recommends that advertisers discontinue claims such as '100% oxo-biodegradable' because such statements suggest that a plastic will quickly or completely biodegrade with the help of

17 EV0422 - Assessing the Environmental Impacts of Oxodegradable Plastics Across Their Life Cycle – UK Report to the Department for Environment, Food and Rural Affairs -s January 2010
18 DEFRA (2010) Oxo-degradable plastics - Q&A
19 Published by the American Chemical Society :E nviron. Sci. Technol., 2015, 49 (6), pp 3769–3777
20 Federal Trade Commission Announces Actions Against Kmart, Tender and Dyna-E Alleging Deceptive ‚Biodegradable' Claims. www.ftc.gov/opa/2009/06/kmart.shtm. Accessed on February 15, 2014

these additives[21].

Oxo-degradation is sometimes promoted as a strategy to reduce litter, but whether this is actually a beneficial or harmful, depends on what happens to the plastic fragments in the environment. There is concern that the plastic fragments may be ingested by insects and animals, but this has not been investigated. Notwithstanding, the United Nations Environment Programme (UNEP) stresses that littering[22] is a behavioural problem and must be resolved by raising environmental awareness and by the establishment of appropriate waste management systems.

There is scant scientific data to indicate whether oxo-degradable polymers will biodegrade sufficiently in anaerobic digestion plants.

For more technical information on difference between bioplastics and additives we suggest to refer to the knowledge-base of the EU Bioplastics Association at: www.en.european-bioplastics.org/.

6. Testing and certification

6.1 Test methods

There are a number of different test methods manufacturers can use to assess whether a product can be claimed to be 'compostable'. A non-exhaustive list is shown in Table 2.

Table 2 – Examples of Compostablilty Standards

Standard Name	Description	Geographical Area
ISO 17088	Specifications for compostable plastics	International
ASTM D 6400-04	Standard Specification for Compostable Plastics	USA
BNQ – 9011-911/2007	Standard Specification for compostable plastic bags	CANADA
EN 13432	Packaging - Requirements for packaging recoverable through composting and biodegradation - Test scheme and evaluation criteria for the final acceptance of packaging	EU
EN 14995	Broadens the scope of plastics when used in non-packaging applications	EU
EN 14045	Packaging - Evaluation of the Disintegration Of Packaging Materials In Practical Oriented Tests Under Defined Composting Conditions	EU
AS 4736-2006	Biodegradable pastics- Biodegradable plastics suitable for composting and other microbial treatment	Australia
G-5: 2002/2012	Standards for Compostable GreenPla Products	Japan

In the European Union (EU) the EN 13432 standard defines what characteristics a material must have in order to be legally defined as 'compostable'. Hence it acts as a reference norm for producers, public authorities, composting industry and consumers. According to EN 13432 standard, compostability is a fulfilment of a set of properties:

- **Biodegradability**, the break down into carbon dioxide, water, biomass at the same rate as cellulose (paper).
- **Disintegrability** or fragmentation, the material is indistinguishable in the compost, that it is not

21 National Advertising Division examines advertising for GP Plastics Corp. "PolyGreen Plastic Bags. Case Report. Publication Date: March 5, 2009
22 United Nations Environment Program (2009, p. 215). Marine Litter – A Global Challenge

visible and does not need to be screened out

- **No heavy metal content**, there is a limit value for the content in compostable plastics
- **Eco-toxicity**, the compost produced from compostable plastics has no negative effects on composting

Biodegradability is determined by measuring the amount of CO2 produced over a certain time period by the biodegrading plastic. The EU-Standard EN 13432 requires 90% biodegradation to be reached in less than six months; the USA-standard ASTM D 6400-04 requires less stringent thresholds of 60% conversion of carbon into carbon dioxide within 180 days for resins made from single polymers and 90% conversion of carbon into carbon dioxide for co-polymers or polymer mixes. This property is quantitatively measured using the standard test method, EN14046[23] (which is also published as ISO 14855: biodegradability under controlled composting conditions).

For biodegradable plastics treated by means of anaerobic digestion, biodegradation can be estimated by following a number of specific standards[24]. According to EN 13432 anaerobic biodegradation and disintegration can be verified as a non-mandatory option: 50% biodegradation is required after two months as anaerobic fermentation is followed by aerobic composting, during which time biodegradation can further continue. According to the European Bioplastics Association[25] 'the discussion and standardisation on requirements for anaerobic bio-degradation or preferably anaerobic treatability is still in an early, initial phase. One idea, which is also circulating, is to require only disintegration after anaerobic testing', arguing that biodegradation can be achieved in subsequent aerobic composting and/or soil application. As an example this approach is widely applied in AD treatment of biowaste in Italy[26].

Disintegration is measured with a composting test (EN14045) and the test material is degraded, together with organic waste, for three months. By sieving the material to determine the non-biodegraded fragments, less than 10% should remain on a 2 mm screen after 120 days. According to the Canadian certification (for plastic bags) disintegration must be at least 90% within 84 days of the composting process.

Eco toxicity is measured by having concentrations of heavy metals below the limits set by the standards and by testing plant growth by mixing the compost with soil in different concentrations and comparing it with controlled, reference compost.

The certification standards are normally oriented to ensure total biodegradability of bioplastics within industrial processes. So the scale in which the composting process takes place has a relevant influence on the process conditions and the evolution of the degradation of the biomaterials and the behaviour of bioplastics can be different at industrial plants from small-scale facilities or within home or community composting. Hence the following chapters highlight specific recommendations for managing bioplastics, and focusing on compostable bags, in small scales composting facilities.

6.2 Home compostability

Compared to industrial plants, home composting is performed using smaller amounts of organic wastes and at significantly lower temperatures and longer processing times. Hence the degradation and compostability of biodegradable plastics in home-composting units needs to be verified using specific test methods, which are derived from those developed for industrial scale composting.

Specific certification for compostable biodegradable plastics treated in home-composters is offered by at

23 Packaging - Evaluation of the ultimate aerobic biodegradability and disintegration of packaging materials under controlled composting conditions - Method by analysis of released carbon dioxide
24 e.g. ISO 11734, ISO 14853, ISO 15985, Ecetoc #28, ASTM D.5210-92, ASTM D.5511-02, ASTM D.5526-94
25 European Bioplastics Association, Fact sheet on Anaerobic Digestion, 2010
26 CIC, Italian Composting and Biogas Consortium, Annual Report 2013.

least two certification schemes[27].

6.3 Certification

For many consumers biodegradable plastics are difficult to distinguish from conventional plastics. In order to avoid contamination of organic waste collected for composting, awareness and education initiatives are helpful to inform the public about what packaging and plastic products can and cannot be composted.

A certification label scheme facilitates the appropriate use of biodegradable plastics by consumers; and if they are to be recycled through a biological treatment process, it also facilitates the activities of waste collection and recycling programmes. In addition, it is also helpful to make customers aware about the distinction between compostable products suitable for use in home composting and larger-scale industrial plants.

Manufacturers of compostable products can obtain certification from a number of certification bodies. They certify conformance to a specified standard, primarily EN 13432 or ASTM D6400. In Europe the most important certification schemes for compliance to EN 13432 are the DIN-CERTCO (Germany), the Belgian OK-Compost label of VINÇOTTE and the Italian COMPOSTABILE – CIC schemes. Currently, the scheme run by the Italian Composting Association, is the only certification programme based on field compostability trials conducted in industrial composting plants.

These on-field certification programmes are very important, because most existing international standards require laboratory biodegradation within 180 days, which may not be compatible with composting duration by some technologies.

Products that meet the test criteria specified in the standards can be awarded certification, which also permits them to use the certification label on their products and marketing materials (Figure 3).

Figure 3 - Example of labels for certification of compostable plastics

Compostability certification gives additional visibility to biodegradable plastics that can undergo recovery in industrial biological treatment processes. It therefore helps consumers to visually identify those plastics that can be recycled in composting (and AD) processes.

Visibility enhancement has been introduced in voluntary schemes and in some selected cases, such as the regional label[28] established in Catalonia (Spain) and used on compostable items. Recently the German Association for Compostable Products (Verbund kompostierbare Produkte e.V.) published recommendations for coherent labelling and design of compostable biowaste bags[29]. The uniform design aims to help consumers and waste collectors to identify certified bags that are suitable for the collection of organic waste and to easily distinguish them from unsuitable, non-biodegradable plastic bags. As the EU Parliament amended in 2015 the Packaging and Packaging Waste Directive (PPWD) requires clear labelling and marking of compostable bags, so consumers can easily identify them as suitable for organic waste collection, helping to keep them out of traditional plastic waste streams.

Regarding compostability of biodegradable plastics, the process of obtaining a certificate is voluntary.

27 For example, the OK Compost Home scheme, Vinçotte.
28 Reference: TES/717/2012, Generalitat de Catalunya
29 Source: European Bioplastics Bulletin 02/2015

Based on positive results, the certification body issues the manufacturer a compliance certificate for products and licenses the manufacturer to use the certification labels. Other statements, even if they are called certificates (statement by the manufacturer about the product), which are not based on results of a certified biodegradability analysis that was performed by an accredited laboratory, are not valid.

7. Current status about the use of biodegradable plastics in organic waste recycling

In municipal solid waste management, biodegradable plastics already play a significant role in some EU member states in at least three distinct ways:

1) Separate collection of bio-waste, and specifically the most putrescible and wet part, namely food waste: a large variety of bags and liners are currently used to facilitate and enhance separate collection and recycling in a biological treatment site (either aerobic or anaerobic).

2) Biodegradable packaging products and/or materials, that are marketed as 'green' packaging, thereby highlighting the possibility that they can be effectively recycled in a biological treatment plant.

3) Other bio-based goods and materials, such as chew bones for dogs, cutlery, dishes and other tableware suitable for processing in a biological treatment plant (either aerobic or anaerobic).

At present, the largest production of biodegradable plastics worldwide is for use as carrier bags and other packaging[30].

Extensive experience has shown that compostable biodegradable plastic bags (and paper bags) enhance the result of separate collection schemes for organic wastes and so play a fundamental role in designing effective source separation schemes for organic wastes in many countries[31].

Intensive collection schemes for food waste imply that each waste producer (family, shops, restaurants, other private enterprise included in the municipal collection scheme) must be equipped with specific collection tools (bags, buckets, wheeled bins) that can be used to easily manage putrescible materials (including cooked substances such as meat, fish, soups, food scraps, etc.).

Families are the largest producer group of food waste. Hence, it is important to ensure that source separation of food waste is convenient, manageable and clean. This can be achieved by equipping each family with small kitchen caddies and compostable bags or liners.

The use of bags for food waste collection is generally intended to:

- Make it possible to collect meat and fish scraps along with vegetables and fruit residues, avoiding nuisance generally related to the delivery of 'loose' material inside the bin;
- Prevent pest attraction (insects) and production of leachate; and
- Keep the bins as clean as possible, hence ameliorating the whole collection chain (from the household, to the collection vehicle up to the composting plant).

So the key factor to achieve high capture rates, and subsequently diversion of food waste to landfills, means cleanliness and convenience for citizens. The use of biodegradable plastic bags instead of conventional plastics offers some additional advantages in this respect:

- The bag itself does not introduce additional contamination to the final compost produced;
- According to a large dataset of waste composition analyses performed in Italy, using biodegra-

30 Bioplastics facts and figures; European Bioplastics, 2013

31 In the USA the EPA estimates that for about 32 million tons of food waste, less than 1 million is recycled, which makes food waste the best area of opportunity to improve our rates of organic recycling; as a comparison yard trimmings is already well established: 21 million tons recycled out of about 33 million generated. That's a recycling rate of 65% - second highest of any material tracked by the EPA. (Source: factsheet on bioplastic BASF).

dable bags sensitizes citizens not to insert non-compostable items in the food waste bin (while the use of plastic bags generates confusion as they are clearly not compostable);

- Biodegradable bags, being transpiring, allow for the use of vented kitchen caddies, which dramatically reduce both odours, leachate (thus avoiding the 'yuck' factor, which impairs citizens' participation) and the weight of food waste collected; and
- Transparent bags also allow for an easy visual inspection of the contents, when used in kerbside organic waste collection schemes.

In these experiences the use of compostable plastics, often delivered for free to households, has to be considered as part of the general management scheme for enhancing the participation in organic waste collection and recycling into quality compost.

The presence of post-consumer plastics by error or negligence into source separated food and garden waste represents a problem for composting facilities; conversely, the use of compostable bags used to separately collect food waste can strongly improve the quality of organic waste. According to the Italian Composting and Biogas Association - CIC[32], if collection from households is carried out with traditional (non-biodegradable) polyethylene bags, the expected content of non-compostable materials (NCM) inside bio-waste is about 9%, while if the collection is performed with compostable bags the level of NCM can drop to 1.4%. So the biodegradable plastics sector potentially can enhance the recovery process of organic waste delivered to composting and biogas plants, if biodegradable plastics used for separate collection are compostable.

The information sheets compiled by the WGBTW members and attached to this document, provide an overview of selected countries that are using biodegradable plastics in connection with biological treatment/recycling processes.

The most relevant and widespread implementation of biodegradable bags for food waste collection is found in Italy, where recent statistics show that with the intensive kerbside collection of food waste based on biodegradable plastics bags and small kitchen caddies, about 85% of food waste is captured, i.e. less than 15% of organic waste is left by citizens in the residual waste.

Regarding anaerobic digestion (AD), we can assume that current biodegradable plastics are not specifically designed to be sufficiently biodegraded under anaerobic conditions. If AD is the final option of food waste, we can point out that:

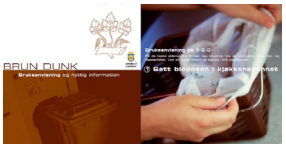
- the use of bio-plastics for collection enhances citizens' participation, thus increasing significantly the amount of food waste collected, and consequently biogas yields;
- compostable biodegradable plastics are often removed before AD during the pre-treatment stage; when the non-compostable content of the rejects of these operations is low, they can be composted aerobically, along with digestate.
- after the pre-treatment stage, it cannot be excluded that a certain amount of biodegradable and compostable plastics reach the digester and finally the digestate. In this case, they offer a higher environmental protection than conventional plastics. By adjusting the retention times in the digester and/or submitting the digestate to a further composting treatment these plastic residues can be transformed into organic matter available to soils.

In the case of AD plants, pre-treatment needs to be effectively designed so as to effectively remove biodegradable bags prior to digestion. Processes combining AD followed by a composting step are better able to ensure that complete biodegradation of these plastics takes place.

32 Ricci M., M. Centemero et al, "Biowaste Management in Italy and Quality Assurance" CIC, Italian Composting and Biogas Consortium; ISWA Congress 2014.

Examples of the use of compostable bags to collect organic wastes are shown in Table 3.

Table 3 – Examples of the use of compostable plastics in the collection of organic wastes for biological treatment

Case (Nation, City)		Case (Nation, City)	
Italy (EU) Milan City		Germany (EU) Landkreis Bad Dürkheim	
Spain (EU) mainly Catalunja and Basque Country)		Norway Stavanger Municipality	
UK (EU) Cardiff (and many other Municipalities)		USA San Francisco	
Brazil Mogi M.		Canada Greater Toronto Area	

8. Analysis of the information sheets about the use of biodegradable plastics in organic waste collection and treatment programmes

The information sheets were compiled on a voluntary basis from the active members of the ISWA WG on Biological Treatment of Waste and by involving relevant institutions or national experts during 2014 and 2015. Most information sheets were compiled for EU countries, two from the North American Continent and one from Japan (Asia).

8.1 Legal drivers

The info sheets first briefly investigates the current situation about separate collection and organic waste recycling (or treatment) by means of composting and/or anaerobic digestion; the legal drivers for developing separate collection and recycling of organic waste are quite diversified: about 30% of the cases have

a national (or regional) target addressing separate collection of biowaste, some with specific goals for collecting organic waste at source. About 50% of the cases have a legal obligation for collecting organic waste separately. In some countries (such as the USA and Canada) targets and obligations can be found only on a regional level and not nationwide.

Generally legislation addresses the main organic waste feedstock produced as municipal solid waste, i.e. food-waste and garden/green-waste. In some cases (for example, in Japan and some northern US States), they specifically address large waste producers, such as the commercial sector, food-industry, etc.

8.2 Bag types

By investigating what types of bags are used for enhancing separate collection of organic waste it come out that paper and biodegradable plastics are usually recommended so to enhance the recycling process of organics; even though traditional plastics still play an important (and disturbing) role in some situations.

Only a limited number of cases have data and estimation about the percentage of bags used for separate collection of biowaste; in countries like Italy, Spain (some Regions), the UK and Finland, where biodegradable plastics bags and liners are commonly delivered to households so to enhance separate collection[33].

The quality of biowaste source segregated in terms of the different types of bags used is investigated regularly in Italy (by the Italian Composting Association), Cataluña (Spain) and the UK (if the plant is subjected to a quality assurance scheme).

Specific national legislation limiting the use of traditional plastic shoppers and carrier bags are enforced in some EU countries like Italy (a ban), in Wales, Northern Ireland and Scotland (a charge). Specific bans on plastic bags are to be enforced in England (UK from autumn 2015), Cataluña[34] (Spain) and in France[35] from 2016. In the USA, California[36] became the first US state to apply a ban on one-way plastic carrier bags first to large grocery stores and then to expanding to smaller stores the year after. Similar initiatives are to be found in Africa since 2008 in Rwanda[37] and more recently in Mauritania[38]. Obviously these legislative initiatives limit the use of one-way bags with potential positive outcomes on littering and marine pollution; they also drive the market for reusable items (i.e. carrier bags) and bags made of paper and biodegradable plastics, whose 'second life' can be as a liner for organic waste collections.

8.3 Standards and labelling

Standards clearly defining the type of biodegradable plastic that can undergo recycling in composting and anaerobic digestion plants are a clear element both for manufactures and for the recycling sector for biowaste. The existence of a national standard was investigated by the info-sheet; for the EU countries the national standards comply with EN 13432, and some labels promoting visibility of compostable items are available at regional level only (e.g. in Cataluña in Spain). Both the USA and Canada have their national standards. These three main standards differ significantly in some details and aspects that are not investigated in detail in this document.

Labelling of biodegradable plastics can play an important role in raising consumer awareness and by helping to clearly distinguish compostable plastics. According to the info-sheets, labels for compostable

33 The number of info-sheet investigated is not sufficient to produce a statistical evidence.
34 http://comerc.bcn.cat/en/current-news/catalonia-ban-free-plastic-bags-2016
35 http://www.france24.com/en/20141011-france-outlaw-single-use-plastic-bags-2016
36 The ban will be enforced in 2016. Source: http://www.nbcnews.com/science/environment/california-governor-signs-law-ban-plastic-bags-n214911
37 http://www.theguardian.com/commentisfree/2014/feb/15/rwanda-banned-plastic-bags-so-can-we
38 http://www.bbc.com/news/world-africa-20891539

plastics are found in seven out of the ten cases investigated.

The info-sheets did not give an univocal insight about the acceptance of different types of biodegradable plastic items (i.e. bags, rigid packaging, etc.) at composting plant; the answers suggest that generally compostable bags are accepted, while different kinds of items need to be evaluated with the plant manager; this is due to the fact that AD and composting plants are designed for treating organic waste (and not packaging) and that in some cases the use of biodegradable plastic is associated with the risk of increasing the amount of conventional plastics delivered to the plant. In practice, the current situation in two EU countries with an established biowaste collection seems to refute this statement: the average non-compostable content of biowaste in Italy[39], a country adopting compostable plastics as a standard for food-waste collection, does not exceed 4,5% in about 70% of the waste analysed, whilst in Germany – a country relying on paper bags for organic waste collection, the non-compostable fraction varies[40] between 1% in rural areas up to 10% in urban settlements.

9. Conclusions and discussion

The ISWA WGBTW has investigated the topic of biodegradable plastics from the perspective of its impact on the biological treatment of waste.

Organic waste represents the largest portion of municipal solid waste (MSW) in many countries. It ranges from 20-40% in higher-income countries, and up to 60-80% in lower-income countries[41]. It is observed that the percentage of food waste in MSW is negatively correlated to both GDP per capita and the amount of MSW generation per capita. Hence separate collection of organic waste, and specifically food waste, is an important factor in managing MSW, so as to minimize residual waste and reduce its environmental impact after final disposal.

The use of compostable plastic and paper bags for organic waste collections and incorporating them in the waste treatment process is a proven procedure in many countries with a developed sector for organic recycling. However, this approach is sensitive to the misuse of conventional plastic bags for bio-waste collection. In addition, misunderstanding of the compostability of plastic products, mostly packaging, often leads to the disposal of such products in organic waste bins. In order to avoid contamination of organic waste collected for composting, major awareness and education initiatives are necessary to inform policy makers and the public about what kinds of biodegradable plastics can and cannot be composted.

Applying a standard code and/or pattern for organic waste collection bags – either at regional or national levels - may help the public and waste collectors be better able to recognize compostable plastic from non-biodegradable ones. From the point of view of marketing, further research is required.

For the time being, voluntary certification labels for compostability provide visibility to biodegradable plastics that can undergo recovery in industrial biological treatment processes. There is a need for improved promotion by local governments to raise awareness about biodegradable plastics and their correct use. There is the possibility to develop a globally recognised label based on the ISO standard, and this should be investigated further.

Overall, the potential dis-benefits associated with the use of biodegradable plastics are outweighed by the benefits that can be achieved through the efficient and effective collection and treatment of organic wastes made possible through their use.

39 CIC, Italian Composting and Biogas Consortium, Annual Report 2013.
40 German Federal Ministry of Environment, UBA-Studie 43/2010
41 Sources: EUROSTAT 2012; ISWA Paper “Food Waste As A Global Issue”, 2013

10. Attachment: Info sheets

The info-sheets were compiled by following institutions and authors.

Country	Authors
Belgium (region of Flanders)	Association of Flemish Cities and Municipalities
Canada	KGS Group with support from the Compost Council of Canada
Czech Republic	Ministry of the Environment, Czech Republic
Finland	Finnish Solid Waste Association, FSWA (fin, Jätelaitosyhdistys - JLY)
France	Veolia Environnement S.A.
Germany	Verband kommunaler Unternehmen e.V.
Hungary	National Waste Management Agency
Italy	CIC - Italian Biogas and Composting Association
Japan	National Institute for Minamata Disease, Ministry of the Environment
Portugal	VALORSUL SA
Spain (Catalonia)	BCn-Ecologia, Urban Ecology Agency of Barcelona
UK	CIWM, the Chartered Institution of Wastes Management
USA	Novamont, USCC, BPI, BioCycle

The following abbreviations are used in the info-sheets:

Abbreviation	Meaning
AD	Anaerobic Digestion
BP	Bioplastics
BW	Bio-waste
CBP	Compostable Bioplastics
DtD	Door to door collection
FW	Food Waste
GW	Garden Waste
MSW	Municipal Solid Waste
P	Paper
PE	Polyethylene
PP	Polypropylene

Questions:	Country	Belgium (region of Flanders)	Canada	Catalunya	Czech Republic
	Contact name (person filling the form)	*Association of Flemish Cities and Municipalities*	*KGS Group*	*Urban Ecology Agency of Barcelona*	*Ministry of the Environment, Czech Republic*
1. Questions regarding separate collection and bio-waste recycling or treatment	1.1 Is there a national target, obligation or plan for separate collection of bio-waste? Describe briefly.	Green waste obligaton; biowaste option	No, waste managemet is provincial issue	Obligation with limits on impurities	Obligation planned for 01/01/2015
	1.2 Which kinds of bio-waste (i.e. food-, garden-, bio-waste) are addressed by national legislation for MSW? Which waste producers are involved with such national legislation?	GW, BW	Not applicable on a national basis	FW, GW	FW, GW; municipalities
	1.3 What types of bags are used for enhancing separate collection of bio-waste?	container, bags (n.a.)	P, PE	CBP	Biodegrable
	1.4a For separate collection of bio-waste, what is the percentage of bags used for separate collection? please quote: (Please quote estimation if no official data available)			Estimation: depends on collection system (DtD - container)	
	- %Paper bags on total bags?	n.a.	n.a.	0	n.a.
	- % Compostable plastic bags on total bags?	n.a.	n.a.	Almost 100 % in DtD collection	n.a.
	- % PE bags on total bags?	n.a.	n.a.	>80% (container)	n.a.
	1.4b Do you investigate the type of bags regularly at composting/AD plants?	n.a.	n.a.	yes	No
	1.5 Is there a technical prescription or national legislation addressing the separate collection of bio-waste and linking to bio-plastics?	n.a.	n.a.	No	Yes, single municipalities
	1.6 What percentage of population is served by separate collection schemes for bio-waste?	n.a.	61%	>95%	n.a.
	1.7 How many composting plants and AD plants for separate collected bio-waste exist in your country?	23/2	350	22, no data on AD	266/10
	1.8 What is the annual amount (in metric tons/year) of the following separately collected and sent to AD or composting:				
	- Food waste	282.000 BW: GW+-veget+fruit	n.a.	389 236	n.a.
	- Garden & park waste	463 000	n.a.	99 180	n.a.
	- Other biodegradable waste (i.e. sludge, agro-industrial residues, etc)	n.a.	n.a.	n.a.	n.a.
2. Questions regarding legislation and/or rules on the compostibility of bio-plastics	2.1 Are there national (or regional) standards for defining the compostability of bio-plastics? If yes, please quote legislation and compostability standard applied	EN 13432	BNQ 0017-988)	TES/717/2012 (just in Catalunya)	EN 13432
	2.2 Is there a national label for certifying compostable plastics? If yes, please quote legislation and compostability standard applied	n.a.	Yes	TES/717/2012	No
	2.3 Does a national bio-plastics association exists?	Yes	No	n.a.	No

Questions:	Country	Belgium (region of Flanders)	Canada	Catalunya	Czech Republic
	Contact name (person filling the form)	*Association of Flemish Cities and Municipalities*	*KGS Group*	*Urban Ecology Agency of Barcelona*	*Ministry of the Environment, Czech Republic*
3. Questions addressing the recyclability of bio-plastics at composting or AD plants	3.1 Do composting plants usually accept bio-plastics?	Yes	Not always	Yes	No
	3.2 What kinds of bio-plastics is accepted by composting plants? Are there any limiting conditions for acceptance of SPECIFIC bio-plastics ITEMS at composting plants?	OK compost labeled	n.a.	n.a.	All EN 13432 cerfified
	3.3 Do AD plants usually accept bio-plastics?	Yes	Not always	Yes	No
	3.4 What kinds of bio-plastics are accepted by AD plants? Are there any limiting conditions for acceptance of bio-plastics at AD plants?	OK compost labeled	n.a.	All	EN 13432 cert.
	3.5 Is there a national legislation limiting the use of traditional plastics or promoting the use of bio-plastics?	Voluntary areements	No	Forseen	Yes, just packaging
	3.6 What kinds of items, products, commercial or industrial sectors are involved with such national legislation?	All kinds of packaging	n.a.	PE carrier bags	All kinds of packaging
	3.7 What is the current impact of “traditional” plastics on the composting sector?	2-3%	no data	1,9% plastic bags	after seperation just negligible part of non-degradables left
	3.8 What are the problems associated with bio-plastics faced by composting and AD plants? How much percent of accepted bio-plastics can really be recycled successfully at those plants?	sometimes removed by sifter in advance	in absence of certification removed in advance	Bioplastics sorted out in advance	Slow degradation of wrongly declared bioplastics; hazardous additives
4. Country outlook	4.1 What will be the development of bio-plastics in your country?	n.a.	long term strategy currently under development	Expansion of use of compostable bags	Depending on EU strategies

Questions:	Country	Finland	France	Germany
	Contact name (person filling the form)	*Finnish Solid Waste Association, FSWA (fin, Jätelaitosyhdistys - JLY)*	*Veolia Environnement S.A.*	*Verband kommunaler Unternehmen e.V.*
1. Questions regarding separate collection and bio-waste recycling or treatment	1.1 Is there a national target, obligation or plan for separate collection of bio-waste? Describe briefly.	Obligation + Landfill ban from 2016	No, but targets for decrease of BW landfilling & higher recycling rate of MSW	Obligation from 01/01/2015
	1.2 Which kinds of bio-waste (i.e. food-, garden-, bio-waste) are addressed by national legislation for MSW? Which waste producers are involved with such national legislation?	FW, GW; all producers	GW & FW from households, restaurants, service sector, industrial sectors	BW, GW
	1.3 What types of bags are used for enhancing separate collection of bio-waste?	P, CBP	P, PE, container	PE, P, biodegradable
	1.4a For separate collection of bio-waste, what is the percentage of bags used for separate collection? please quote: (Please quote estimation if no official data available)	Estimation		Estimation; ~20% no bags
	- %Paper bags on total bags?	5%	n.a.	5%
	- % Compostable plastic bags on total bags?	90%	n.a.	5%
	- % PE bags on total bags?	5%	n.a.	70%
	1.4b Do you investigate the type of bags regularly at composting/AD plants?	No	n.a.	n.a.
	1.5 Is there a technical prescription or national legislation addressing the separate collection of bio-waste and linking to bio-plastics?	No	No	yes
	1.6 What percentage of population is served by separate collection schemes for bio-waste?	>60%	36% (DtD); 96% with access to GW recycling centres	~52%
	1.7 How many composting plants and AD plants for separate collected bio-waste exist in your country?	20/14	108/2	900/100
	1.8 What is the annual amount (in metric tons/year) of the following separately collected and sent to AD or composting:		4.692.000 (BW + green waste)	
	- Food waste	n.a.	n.a.	1 800 000
	- Garden & park waste	n.a.	n.a.	n.a.
	- Other biodegradable waste (i.e. sludge, agro-industrial residues, etc)	n.a.	n.a.	n.a.
2. Questions regarding legislation and/or rules on the compostibility of bio-plastics	2.1 Are there national (or regional) standards for defining the compostability of bio-plastics? If yes, please quote legislation and compostability standard applied	No	No	EN 13432 and DIN Certco
	2.2 Is there a national label for certifying compostable plastics? If yes, please quote legislation and compostability standard applied	EN 13432	EN 13432	"Coffee Bean" (Din Certco)
	2.3 Does a national bio-plastics association exists?	No	n.a.	Yes

Questions:	Country	Finland	France	Germany
	Contact name (person filling the form)	*Finnish Solid Waste Association, FSWA (fin, Jätelaitosyhdistys - JLY)*	*Veolia Environnement S.A.*	*Verband kommunaler Unternehmen e.V.*
3. Questions addressing the recyclability of bio-plastics at composting or AD plants	3.1 Do composting plants usually accept bio-plastics?	Yes		Depends on municipality
	3.2 What kinds of bio-plastics is accepted by composting plants? Are there any limiting conditions for acceptance of SPECIFIC bio-plastics ITEMS at composting plants?	All	no data	EN 13432 certified
	3.3 Do AD plants usually accept bio-plastics?	Yes	no data	No
	3.4 What kinds of bio-plastics are accepted by AD plants? Are there any limiting conditions for acceptance of bio-plastics at AD plants?	All	no data	EN 13432 cert., low acceptance
	3.5 Is there a national legislation limiting the use of traditional plastics or promoting the use of bio-plastics?	no	No data	No
	3.6 What kinds of items, products, commercial or industrial sectors are involved with such national legislation?	n.a.	No data	n.a.
	3.7 What is the current impact of “traditional” plastics on the composting sector?	0,3 - 0,6% non compostable plastics	no data, but product matches with standards on compost quality	varying from <2,5 to >15%
	3.8 What are the problems associated with bio-plastics faced by composting and AD plants? How much percent of accepted bio-plastics can really be recycled successfully at those plants?	Bioplastics sorted out in advance	No data	n.a.
4. Country outlook	4.1 What will be the development of bio-plastics in your country?	Development of easier & faster degradable bioplastics	n.a.	n.a.

Questions:	Country	Hungary	Italy	Japan
	Contact name (person filling the form)	*National Waste Management Agency*	*CIC - Italian Composting and Biogas Association*	*National Institute for Minamata Disease, Ministry of the Environment, Japan*
1. Questions regarding separate collection and bio-waste recycling or treatment	1.1 Is there a national target, obligation or plan for separate collection of bio-waste? Describe briefly.	Obligation	No; but target to collect 65% of MSW seperately	Biomass recycling target for 2020: foodwaste 40%
	1.2 Which kinds of bio-waste (i.e. food-, garden-, bio-waste) are addressed by national legislation for MSW? Which waste producers are involved with such national legislation?	All	FW, GW; all producers	FW from food manufactures, retailers, wholesalers & food service industries.
	1.3 What types of bags are used for enhancing separate collection of bio-waste?	PE	P, CBP	PE, biodegrable
	1.4a For separate collection of bio-waste, what is the percentage of bags used for separate collection? please quote: (Please quote estimation if no official data available)		Estimation	
	- %Paper bags on total bags?	0%	1-2%	n.a.
	- % Compostable plastic bags on total bags?	5%	>70%	n.a.
	- % PE bags on total bags?	95%	<30%	n.a.
	1.4b Do you investigate the type of bags regularly at composting/AD plants?	No	yes	No
	1.5 Is there a technical prescription or national legislation addressing the separate collection of bio-waste and linking to bio-plastics?	No	yes	Yes, single municipalities
	1.6 What percentage of population is served by separate collection schemes for bio-waste?	n.a.	50-65%, depending on regions	n.a.
	1.7 How many composting plants and AD plants for separate collected bio-waste exist in your country?	68, no data on AD	260/32	97/5
	1.8 What is the annual amount (in metric tons/year) of the following separately collected and sent to AD or composting:			
	- Food waste	180 000	2.123.330 + 447.470 (AD)	n.a.
	- Garden & park waste	2 000 000	1 408 922	n.a.
	- Other biodegradable waste (i.e. sludge, agro-industrial residues, etc)	420 000	859 913	n.a.
2. Questions regarding legislation and/or rules on the compostibility of bio-plastics	2.1 Are there national (or regional) standards for defining the compostability of bio-plastics? If yes, please quote legislation and compostability standard applied	No	EN 13432	No
	2.2 Is there a national label for certifying compostable plastics? If yes, please quote legislation and compostability standard applied	Just for plastic bags	Compostabile CIC	GreenPla Identification System
	2.3 Does a national bio-plastics association exists?	No	Yes	Yes

Questions:	Country	Hungary	Italy	Japan
	Contact name (person filling the form)	*National Waste Management Agency*	*CIC - Italian Composting and Biogas Association*	*National Institute for Minamata Disease, Ministry of the Environment, Japan*
3. Questions addressing the recyclability of bio-plastics at composting or AD plants	3.1 Do composting plants usually accept bio-plastics?	n.a.	Yes	Yes
	3.2 What kinds of bio-plastics is accepted by composting plants? Are there any limiting conditions for acceptance of SPECIFIC bio-plastics ITEMS at composting plants?	n.a.	Mainly bags (EN13432)	Bags
	3.3 Do AD plants usually accept bio-plastics?	n.a.	Yes	Yes
	3.4 What kinds of bio-plastics are accepted by AD plants? Are there any limiting conditions for acceptance of bio-plastics at AD plants?	n.a.	Mainly bags (EN13432)	Yes
	3.5 Is there a national legislation limiting the use of traditional plastics or promoting the use of bio-plastics?	No	Ban on bags	Yes, just packaging
	3.6 What kinds of items, products, commercial or industrial sectors are involved with such national legislation?	n.a.	"One-way shoppers and bags; reusable &compostable bags are excluded "	All involved in packaging, except small sized business
	3.7 What is the current impact of “traditional” plastics on the composting sector?	no data	2-5% non-compostables in FW; Composting sector pays ~4.8 Mio to dispose 40.000 t/year of plastics	no data
	3.8 What are the problems associated with bio-plastics faced by composting and AD plants? How much percent of accepted bio-plastics can really be recycled successfully at those plants?	no data	Problem: Fake comp. and Oxo-degrad. plastics ; 100% of compostable bioplastics can be recycled	no data
4. Country outlook	4.1 What will be the development of bio-plastics in your country?	Reduction of EPR fee on bioplastics	Growing use of other compostable products besides bags	Further promotion

Questions:	Country	Portugal	UK	USA
	Contact name (person filling the form)	*VALORSUL SA*	*CIWM, the Chartered Institution of Wastes Management*	*Novamont, USCC, BPI, BioCycle*
1. Questions regarding separate collection and bio-waste recycling or treatment	1.1 Is there a national target, obligation or plan for separate collecti-on of bio-waste? Describe briefly.	50% target for recycling MSW, also considering biowaste	50% recycling target in England & N. Irland; Wales 70%; FW obligation in Scotland	No
	1.2 Which kinds of bio-waste (i.e. food-, garden-, bio-waste) are addressed by national legislation for MSW? Which waste producers are involved with such national legislation?	FW, GW; all producers	n.a.	GW; some northeastern states address commercial BW
	1.3 What types of bags are used for enhancing separate collection of bio-waste?	PE, PP	P, BP, PE	CBP, P
	1.4a For separate collection of bio-waste, what is the percentage of bags used for separate collection? please quote: (Please quote estimation if no official data available)		data based on % of population served by FW collection	
	- %Paper bags on total bags?	n.a.	8%	n.a.
	- % Compostable plastic bags on total bags?	n.a.	92%	n.a.
	- % PE bags on total bags?	n.a.	<1%	n.a.
	1.4b Do you investigate the type of bags regularly at composting/AD plants?	n.a.	yes (by plant operators)	No
	1.5 Is there a technical prescription or national legislation addressing the separate collection of bio-waste and linking to bio-plastics?	Yes, stresses the importance of promoting the reduction of the consumption of plastics bags	Yes	Yes, single municipalities
	1.6 What percentage of population is served by separate collection schemes for bio-waste?	n.a.	18% FW	2%
	1.7 How many composting plants and AD plants for separate collec-ted bio-waste exist in your country?	2/1	323/34	347+/<10
	1.8 What is the annual amount (in metric tons/year) of the following separately collected and sent to AD or composting:			
	- Food waste	70 000	260.000 FW, 1.352.00 mixed FW&GW + 688.800 (AD)	2 893 604
	- Garden & park waste	50 000	3 276 000	19 590 000
	- Other biodegradable waste (i.e. sludge, agro-industrial residues, etc)	0	312.000 + 991.200 (AD)	n.a.
2. Questions regarding legislation and/or rules on the compostibility of bio-plastics	2.1 Are there national (or regional) standards for defining the compostability of bio-plastics? If yes, please quote legislation and compostability standard applied	No	EN 13432	ASTM
	2.2 Is there a national label for certifying compostable plastics? If yes, please quote legislation and compostability standard applied	No	Din Certco; Vincotte	Yes
	2.3 Does a national bio-plastics association exists?	No	No	Yes

Questions:	Country	Portugal	UK	USA
	Contact name (person filling the form)	*VALORSUL SA*	*CIWM, the Chartered Institution of Wastes Management*	*Novamont, USCC, BPI, BioCycle*
3. Questions addressing the recyclability of bio-plastics at composting or AD plants	3.1 Do composting plants usually accept bio-plastics?	Yes	Yes	Yes
	3.2 What kinds of bio-plastics is accepted by composting plants? Are there any limiting conditions for acceptance of SPECIFIC bio-plastics ITEMS at composting plants?	n.a.	Mainly bags (EN13432)	ASTM certified, mostly bags
	3.3 Do AD plants usually accept bio-plastics?	Yes	No	Few
	3.4 What kinds of bio-plastics are accepted by AD plants? Are there any limiting conditions for acceptance of bio-plastics at AD plants?	n.a.	some accept EN 13432 cert.	ASTM cert., low acceptance
	3.5 Is there a national legislation limiting the use of traditional plastics or promoting the use of bio-plastics?	no	Carrier bag charge in Wales, N Ireland, Scotland	No
	3.6 What kinds of items, products, commercial or industrial sectors are involved with such national legislation?	n.a.	Single use carrier bags	n.a.
	3.7 What is the current impact of “traditional” plastics on the composting sector?	plastic bags in Composting: ~3%; AD: ~6-7%	Contamination responses 2012: 262 (contamination levels: >10%: 4x; 6-10%: 5x; 1-5%: 100x; <1%: 153x)	no data
	3.8 What are the problems associated with bio-plastics faced by composting and AD plants? How much percent of accepted bio-plastics can really be recycled successfully at those plants?	double-bagged biowaste hampers biodegradation	Problems with PE/oxo-degr. polymers; plastics blocking pumps&pipes; no sufficient biodegrading	short processing time for many industrial composters; Bioplastics forbidden in compost for organic farming
4. Country outlook	4.1 What will be the development of bio-plastics in your country?	Depending on EU strategies	Depending on acceptance at AD	Increase of compostable food service products

ISWA
International Solid Waste Association

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Working Group on Biological Treatment of Waste

The Working Group on Biological Treatment of Waste (WGBTW) addresses the biological treatment of the organic fraction of solid waste through aerobic and anaerobic decomposition processes.

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