Study on coherence of waste legislation

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Abstract

This study is a critical analysis of the adequacy of the waste stream Directives to contribute to resource efficiency and move towards a "recycling society". This analysis covers in particular: potential gaps, inconsistencies and overlaps between the waste stream Directives and other elements of EU waste legislation; the effectiveness and efficiency of the current waste stream Directives; and potential alternative approaches in the design of legislation as well as upcoming challenges for the EU waste legislation related to recycling.

A first area where coherence could be improved concerns the scope of waste coverage by EU legislation; key examples of waste streams of growing concern which may not adequately be covered by regulatory provisions includes plastic waste, construction and demolition waste, and bio-waste, among others. A possibility identified by the study could be to consider material-based reuse/ recovery/recycling targets in addition to the current product-based targets, which could bring significant environmental benefits; however, the practicalities and associated costs of such an option would merit a detailed investigation. Another area for improvement is the harmonisation of the waste stream Directives with the Waste Framework Directive, in particular with regard to the concepts and definitions that are common to all Directives.

Overall, the waste streams Directives appear to have provided significant environmental benefits to date at reasonable costs, though limited ex-post analysis on socio-economic effects is currently available. Future challenges for the EU waste legislation are mainly related to the full implementation and enforcement of existing legislation as well as the integration of new concepts in the waste stream Directives such as waste hierarchy, life-cycle thinking, resource efficiency, ecodesign, etc. First of all, a number of barriers to the proper implementation of the waste stream Directives need to be overcome in order to achieve higher recycling levels and resource efficiency. Secondly, the enforcement of corollary acquis such as the Landfill Directive and the Waste Shipment Regulation needs to be strengthened, as they could also contribute to achieving higher levels of recycling; however it is difficult to estimate the extent to which recycling could be increased in the absence of any reliable data. Finally, waste streams Directives seem to be flexible and adaptable enough to take into account future technical and scientific advancements, e.g. new types of waste streams/materials, new evidence on environmental impacts of waste, new treatment technologies.

The study has identified several areas and questions, which would deserve further investigation, such as the practical feasibility of implementing a material-based approach to waste management and legislative options for integrating conceptual changes such waste hierarchy, life-cycle thinking, resource efficiency and ecodesign into the recycling legislation. Other areas for further research include carrying out a more systematic and comprehensive exercise to identify gaps in the scope of EU waste legislation coverage and conducting a reflection on how to better integrate ecodesign provisions influencing end-of-life impacts into current legislation.

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Executive summary

Context and objectives

The understanding of environmental concerns and the priorities in EU waste legislation have evolved significantly over the years. Although the waste stream Directives have been revised or are currently being revised to take into account new knowledge and experience, the overall coherence of these Directives and their links with other elements of waste legislation raises a number of challenges, in particular as new concepts and priorities have been introduced over the years.

This study presents a critical analysis of the adequacy of the waste stream Directives to contribute to resource efficiency and move towards a "recycling society". This analysis covers in particular: potential gaps, inconsistencies and overlaps between the waste stream Directives and other main elements of EU waste legislation; the effectiveness and efficiency of the current waste stream Directives; and potential alternative approaches in the design of legislation as well as upcoming challenges in the development of EU waste legislation related to recycling.

It is a meta-study that identifies future directions to achieve a better coherence among the existing and future waste legislation. It uses a number of practical examples to illustrate potential inconsistencies and inefficiencies related to the design and implementation of the waste stream Directives, in order to highlight key issues to be addressed.

Key findings and recommendations

Several types of coherence issues need to be addressed, from scope of waste-stream Directives to harmonisation with the concepts introduced in the Waste Framework Directive (WFD)

First aspect of coherence deals with the scope of waste coverage by the existing EU legislation. Some waste streams and waste materials of growing concern such as construction and demolition waste, bio-waste, plastics, may not yet be adequately covered by regulatory provisions aiming to limit their environmental impacts and to internalise the costs of collection and treatment (producer responsibility requirements). Management of such waste streams or materials would probably benefit from more comprehensive regulatory provisions. A possibility could be to implement material-based reuse/ recovery/ recycling targets in addition to the current product-based targets. This could bring significant environmental benefits as it would enable to cover a wider range of waste streams and to better anticipate possible environmental concerns related to new waste streams. This could also strengthen the links between waste management and resource use, improve coherence with the resource efficiency policy, and help in promoting the functioning of markets for recyclates. However, the practicalities, associated costs, and potential benefits of such an option would need further investigation.

Another area for improvement could be the harmonisation of the waste stream Directives with the concepts introduced by the WFD, in particular with regard to the concepts of waste hierarchy and life-cycle thinking and basic definitions that are common to all Directives such as producer responsibility, reuse, preparation for re-use, recycling, recovery, etc. An additional aspect to improve overall coherence with the WFD and the Thematic Strategies on sustainable use of resources and waste prevention and recycling is to put more emphasis on waste prevention and product design in the waste stream Directives. Finally, the inclusion in the waste stream Directives of additional provisions concerning the quality of separate collection, the quality of treatment operations and the quality of recyclates produced need to be considered, as these are significant drivers for increased recycling.

Regarding the adequacy of quantitative targets contained in the waste stream Directives, it would be challenging to increase the current levels of targets of the Packaging Directive and End-of-Life Vehicles (ELV) Directive and the additional benefits from such increases may be limited. On the other hand, significant environmental benefits could be achieved by raising the targets of the Waste Electrical and Electronic Equipment (WEEE) Directive (as proposed in the recent recast). With regard to the Batteries Directive, information on implementation on current targets is not available yet, therefore it is too early to draw any conclusions. Beyond the achievement of quantitative targets set in the waste stream Directives, more emphasis should be placed on ensuring that all waste is actually treated in facilities that comply with the legislation, especially in the case of ELVs and WEEE.

Besides, there are significant differences and inconsistencies in the implementation of the waste stream Directives from one Member State (MS) to another, which creates additional difficulties for businesses operating in several MS. This aspect seems to be at least as critical as overall coherence issues between the waste stream Directives.

Overall, the waste streams Directives appear to have provided significant environmental benefits to date at reasonable costs, however limited ex-post analysis on socio-economic effects is currently available.

The waste streams Directives appear to have provided significant benefits from an environmental point of view, in particular with regard to resource efficiency, greenhouse gases emission reductions, energy savings and reduction in the release of hazardous substances. Nevertheless, higher benefits could be achieved by increasing collection and recycling and continuing efforts to divert waste from landfilling and incineration.

With regard to economic aspects, overall the waste stream Directives seem to have had a positive effect on the EU internal market and the implementation of the producer responsibility principle has generally resulted in cost savings for public authorities. On the other hand, their implementation has resulted in substantial operating costs and administrative burden to companies, except in the case of the ELV Directive because of the higher monetary value of ELVs compared to other waste streams. Finally, the effect on R&D and innovation remains unclear and not very well documented, except for the ELV Directive where significant innovation in treatment techniques has been reported.

With regard to social effects, limited ex-post analysis is available but it seems that the Directives have contributed to job creation: levels of material recycling have increased, leading to the development of new markets with associated jobs.

Harmonising the waste stream Directives would likely provide additional environmental benefits while reducing implementation costs for companies and MS. Integration of strengthened ecodesign requirements is also an important parameter that could improve the cost-effectiveness of the waste stream Directives.

In addition to improved coherence between the waste stream Directives and the WFD, an important issue to be addressed to improve cost-effectiveness is the consistency of transposition between MS. Indeed, significant costs and administrative burden for companies result from inconsistencies in legal requirements between MS, due to differences in the Directives' transposition.

Future challenges for EU legislation on recycling are mainly related to the full implementation and enforcement of existing legislation as well as the integration of new concepts in the waste stream Directives (waste hierarchy, life-cycle thinking, resource efficiency, ecodesign).

A number of barriers to the proper implementation of the waste stream Directives need to be overcome in order to achieve higher recycling levels and resource efficiency. Some obstacles are specific to each waste stream Directive, for example: the vagueness of some CEN standards developed to comply with Essential Requirements of the Packaging Directive; the difficulty in tracking what happens to ELVs once they are removed from registration; the difficulty in incentivising consumers to turn in small electronics and electrical products or batteries; and the complexity of accounting system for the transfer of costs from producers/retailers to waste treatment organisations. Other barriers to be addressed are common to all Directives, such as the lack of public awareness on existing collection systems or the fluctuations in the price of recycled materials.

The enforcement of corollary acquis such as the Landfill Directive and the Waste Shipment Regulation needs to be strengthened, as it could also contribute to achieving higher levels of recycling; however it is difficult to estimate the extent to which recycling could be increased in the absence of any reliable data. Previous studies have shown that there is significant area for improvement in the enforcement of these two pieces of legislation. Increased enforcement of the Landfill Directive could lead to increased energy recovery but not necessarily increased recycling, because energy recovery is currently the easiest and most widely used option. MS where significant improvements have been noted in terms of recycling have usually transposed the Landfill Directive in a more stringent manner (e.g. landfill taxes, additional product bans) and these MS have also implemented specific measures to promote separate collection and recycling. For the four waste streams targeted by this study (packaging, ELVs, WEEE, and batteries), better enforcement of the WSR would probably increase the collection rates, by preventing illegal shipments of recyclable waste. It is also important to note that, in order for the Landfill Directive and the WSR to contribute more efficiently to recycling, current market failures in the recycling industry also need to be addressed (capacity for recycling, demand for recycled materials).

Finally, waste streams Directives seem to be flexible and adaptable enough to take into account future changes of a technical and scientific nature, e.g. new types of waste streams/materials, new evidence on environmental impacts of waste, new treatment technologies. In general, the comitology procedure seems to be well adapted to deal with technical evolutions related to the waste stream Directives; however, in some specific cases, an increased use of standards and norms could simplify the implementation of some technical aspects of legislation. The main challenge will be for these waste stream Directives to fully integrate new concepts such as the waste hierarchy, life-cycle thinking, resource efficiency and ecodesign, as this is likely to require substantial changes in objectives, principles, terminology, etc. One possibility would be for the waste streams Directives to refer the WFD for all the aspects that are common to all of them such as definitions, waste hierarchy and life-cycle thinking, producer responsibility, end-of-waste criteria, etc. (which would require amending the WFD). With regard to the need to better integrate ecodesign requirements, several options could be envisaged; for example, end-of-life impacts could be better covered by EU ecodesign legislation (which is currently mostly focused on the use phase and energy efficiency aspects) and/or ecodesign requirements could be strengthened in existing waste stream Directives.

Areas for further investigation

The study has identified several areas and questions, which would deserve further investigation:

- The study has identified several examples demonstrating some gaps in the scope of EU waste legislation coverage. It would be worth carrying out this exercise in a more systematic and comprehensive manner, in order to inform future policy development on this aspect. This would require a comprehensive assessment of waste streams and materials of greatest environmental concern, based on a quantification of life-cycle impacts and analysis of current waste management options. The economic value of the waste materials would also need to be taken into account in the analysis.
- The study has identified that implementing a material-based approach to waste management, in addition to the current waste stream approach, could provide significant environmental benefits. It could however incur significant costs to public authorities and enterprises in the short term in order to implement and enforce material-based quantitative targets at MS level, and to monitor the results. The practical feasibility and associated costs and benefits of such a policy option would deserve further investigation.
- Possible legislative options to integrate conceptual changes such as waste hierarchy, life-cycle thinking, resource efficiency and ecodesign into the recycling legislation should be further investigated.
- A reflection would be needed on how to better integrate ecodesign provisions influencing end-of-life impacts into current legislation. For example, it could be assessed whether end-of-life impacts should be better covered by EU ecodesign legislation (which currently deals mainly with products where the use phase and energy efficiency are the most significant aspects in their life cycle) or whether ecodesign requirements should be strengthened in existing waste stream Directives, or whether both options should be combined.

Chapter 1: Introduction

1.1 Context

The understanding of environmental concerns and the priorities in EU waste legislation have evolved significantly over the years. The 6th Environmental Action Programme (EAP) spelled out the EU's commitment to take the lead on waste prevention and recycling. Among the key mechanisms to achieve the 6th EAP objectives are the two thematic strategies on sustainable use of resources and waste prevention and recycling. The main legal tool for bringing the EU closer to becoming a recycling society is the Waste Framework Directive 2008/98/EC (WFD). It is now the most fundamental measure influencing the future of EU waste policy, and provides new definitions and clarifies the priorities of legislation and policy for waste prevention and management.

Besides the WFD, EU waste legislation includes several Directives focusing on waste streams of high environmental concern such as packaging (94/62/EC), End-of-Life Vehicles (ELV) (2000/53/EC), Waste Electrical and Electronic Equipment (WEEE 2002/96/EC) (Restriction of Hazardous Substances (RoHS 2011/65/EU), and batteries and accumulators (2006/66/EC). Other horizontal legislation related to waste includes the Waste Shipment Regulation (EC 1013/2006), and the Landfill Directive (99/31/EC). Finally, the Industrial Emissions Directive (2010/75/EU) also includes several provisions related to waste management (e.g. incineration).

Although the waste stream Directives have been revised or are currently being revised (e.g. WEEE Directive) to take into account new knowledge and experience in implementation, there are significant conceptual differences for example between some of the older Directives (e.g. Packaging Directive, 1994) and the recent Waste Framework Directive (2008), in part due to varying objectives (e.g. internal market dynamics for the Packaging Directive, and reduction of environmental impacts for the Waste Framework Directive). Such conceptual differences may raise a number of inefficiencies in the implementation of waste legislation, which need to be investigated in order to identify priority issues and how to address them.

1.2 Objectives and scope of the study

The study aims to conduct a critical analysis of the adequacy of these waste stream related Directives to contribute to resource efficiency and move towards a "recycling society". This analysis covers in particular:

- Potential gaps, inconsistencies and overlaps between the five Directives and other main elements of EU waste legislation.
- The effectiveness and efficiency of the current waste stream Directives
- Potential alternative approaches in the design of legislation and upcoming challenges in the development of EU waste legislation related to recycling.

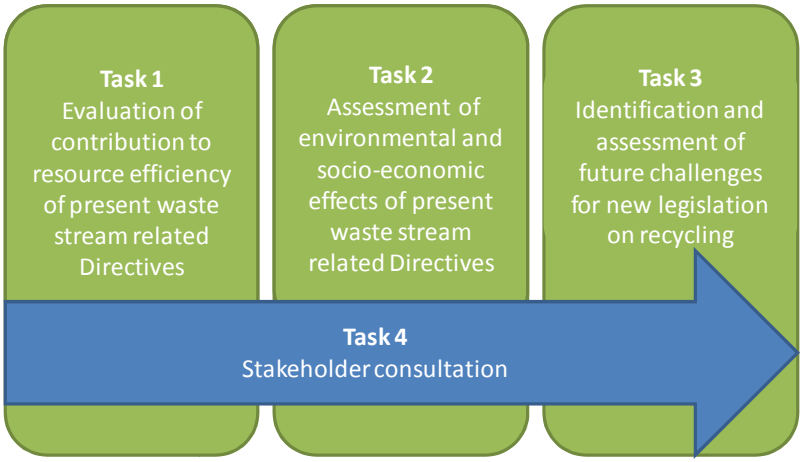
The present study focuses on five waste stream Directives, viz. the Packaging Directive, the Batteries Directive, the ELV Directive, the RoHS Directive, and the WEEE Directive.

1.3 Approach and methodology

This study is a meta-study that identifies future directions to be investigated. It uses a number of practical examples to illustrate potential inconsistencies and inefficiencies related to the design and implementation of the five Directives, in order to highlight key issues to be addressed.

The methodology includes three main tasks (Tasks 1 to 3) and one horizontal task (Task 4), as shown in Figure 1 below.

Figure 1: Task structure



Task 1 consisted of an analysis of the adequacy of the current approach where different waste streams are subject to different Directives. The present approach was evaluated based on its contribution to foster resource efficiency and important issues were illustrated with the help of practical examples.

In **Task 2**, the environmental, economic and social effects of the waste stream related Directives were analysed, in order to conclude whether the expected benefits are achieved at the lowest possible costs.

Following the assessment of the adequacy of the current waste-stream related Directives, key challenges for the development of future legislation on recycling were identified and assessed in **Task 3**.

An essential aspect of the study was the consultation of stakeholders (**Task 4**). Stakeholders were consulted during two workshops organised in April and July 2011 and through questionnaires. The outcomes of these consultations have been integrated in this report.

1.4 Document structure

Following this introductory first chapter, the report is structured as follows:

- Chapter 2 investigates how the present waste stream Directives respond to the resource efficiency goals and what main inconsistencies and gaps need to be addressed
- Chapter 3 provides an overview of the main environmental and socio-economic effects of the waste stream Directives
- Chapter 4 analyses future challenges to be taken into account in the further development of EU legislation on recycling
- Chapter 5 summarises conclusions and recommendations

Finally, the report includes a glossary of key terms and several annexes detailing recycling and resource efficiency drivers (Annex 1), current achievement level of recycling targets (Annex 2), and an analysis of recycling targets (Annex 3).

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Chapter 2: The waste stream Directives and their contribution to resource efficiency

In brief: As of 2006, 3 billion tonnes of waste was generated in the EU-27, an estimated 35% to 45% percent of which is covered by quantitative targets in EU legislation. Key streams of concern that may not be fully covered by quantitative targets include plastics, bio-waste and construction and demolition waste. Drivers to recycling and resource efficiency, concepts such as waste prevention, waste hierarchy, and ecodesign are not harmonised across the waste stream Directives and between these Directives and the Waste Framework Directive, in particular with regard to the concepts of waste hierarchy and producer responsibility. Additionally, there is a lack of standardisation in defining targets on reuse, preparation for re-use, and recovery. An analysis of current recycling targets and further recycling potential indicates that it would be challenging to increase the levels of targets of the Packaging and ELV Directives and the additional benefits may be limited; targets of the WEEE Directive need to be revised as is currently proposed as part of the recast. A number of reporting issues exist in relation to the recycling targets, notably linked to the European List of Waste and the lack of clarity in the definitions of some categories. When comparing a possible material-based approach with the product-based approach currently used in the EU waste legislation, it appears that the two approaches are complementary rather than mutually exclusive. Adding material targets to the current set of waste stream Directives could bring significant environmental benefits; however, cancelling the current waste stream Directives to replace it with a material-based approach could lead to a considerable amount of administrative burden.

This chapter provides an assessment of the extent to which the five waste stream-related Directives in their present structure and content adequately respond to the challenge of significantly and sufficiently improving resource efficiency by preventing waste generation, optimising recycling, and effectively using producer responsibility as an approach to achieve these objectives. This includes an assessment as to what possible alternatives could be identified for restructuring these Directives in order to improve the resource efficiency.

The following four key questions have been analysed:

- To what extent do the current waste stream related Directives cover the most relevant waste streams.
- To what extent do the current waste stream related Directives represent sufficient drivers for resource efficiency and recycling.
- Are current recycling targets adequate and sufficient?

- Would a material-based approach deliver better results in terms of resource efficiency and waste management?

2.1 Waste stream coverage

A fully comprehensive set of waste legislation aiming for resource efficiency would be expected to address the most relevant waste streams in terms of their environmental impacts. This section seeks to address the question of whether the current waste stream related Directives cover the most relevant waste streams and whether additional waste streams should be covered by specific regulatory provisions.

The first step of the analysis was therefore to identify key products and materials associated with the most significant environmental impacts along their life cycle, including in particular their end-of-life. Environmental impacts of waste streams are to some extent linked with volumes of waste produced, therefore a brief overview of existing data on volumes of waste generated in the EU-27 and future growth trends was undertaken. This analysis was complemented by a brief review of current estimates of life-cycle environmental impacts of products and materials, taking into account other parameters than waste quantities.

A comparison with products and materials currently covered by the waste stream-related Directives was then carried out in order to identify potential gaps. Three examples of waste streams of environmental concern, but which are only partially covered by binding targets on reuse and recovery, were identified and assessed in further detail: plastics waste, bio-waste, and construction and demolition waste. Other waste streams that could benefit from more specific legislative requirements are also identified in this section.

2.1.1 Overview of waste streams

Waste generation in the EU-27

EUROSTAT reports waste generation in the EU-27 at 3 billion tonnes of waste in 2006, or 6 tonnes per capita.[1] This includes:

- Mineral and solidified waste, which is generated mainly from mining/quarrying activities and construction/demolition activities, accounted for the largest percentage of waste produced (nearly 70%), representing nearly 2 billion tonnes.
- Recyclable waste, which includes metal waste, paper, rubber, wood, glass, plastic and textile material, accounted for 11%, or 288 million tonnes (Mt) of waste generated.
- Animal and vegetal waste, a category including biodegradable waste and other waste from agriculture, food preparation and products, sludge from washing and cleaning, and slurry and manure, represented 8% or 233 Mt of waste generated.

[1] Eurostat ,2010, Environmental statistics and accounts in Europe (http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-32-10-283/EN/KS-32-10-283-EN.PDF)

- Household waste, which includes mixed waste, bulky waste, kitchen waste and household equipment, but excludes the separately collected fractions of waste, accounted for 7% of total waste generated, or 205 Mt.

Hazardous waste represented approximately 88 Mt in 2006, i.e. 3% of total waste generated in the EU-27; this percentage varies across countries between 1% and 8%. Mineral and solidified waste constitutes the largest percentage of hazardous waste generated at 42%, followed by chemical and medical wastes at 39%. Recyclable waste and discarded equipment waste represented 17% of hazardous waste volumes.

Trends in waste generation

Waste generation across the EU-27 shows a slight increasing trend during 2004 to 2006; non-hazardous waste increased from 2,840 to 2,865 Mt/year, while hazardous waste increased from 78 to 89 Mt/year, hence representing an overall increase from 2,920 to 2,955 Mt/year.[2]

Notably, four waste streams indicate an upward trend:

- **Construction and Demolition (C&D) waste**: Volumes of C&D waste increased between 1995 and 2006, but with large differences between countries (e.g. C&D waste reported in EU-12 countries jumped from 3% of waste generated to 32%)[3].
- **Packaging waste**: Packaging waste from households is increasing; while the main components of this waste stream (glass, metals, paper and cardboard, and plastics) show a relative decoupling with GDP growth between 1997 and 2007, use of wood in packaging materials is growing. Use of plastics in packaging materials is increasing rapidly, from 40% between 1997 and 2006 in the EU-15, compared with a 24% increase for paper and cardboard, and up to a 2% increase for glass and metals packaging.
- **Mining and quarrying waste**: Volumes of mining and quarrying waste have increased exponentially, from 15% of total waste generated in the EU-15 in the period 1997-2001 to 62% of total waste generated in the EU-27 in 2006. This increase is partly due to the EU enlargement, with some new MS having large mining and quarrying industries.
- **Plastic waste**: Despite a slight drop over the 2008-09 period due to the economic crisis, plastic production has been rising steeply over the past fifty years. The EU produces around 25% of plastics worldwide; plastic waste generation is expected to continue growing and expand in terms of materials used, such as innovations in bioplastics and nanoplastics.[4]

Total waste generation is expected to increase by 60-84% between 2003 and 2035, based on various macroeconomic scenarios[2].

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[2]Derived from EUROSTAT 2009a; Arcadis, BIO Intelligence Service et al., 2010, Analysis of the evolution of waste reduction and the scope of waste prevention, for DG ENV (http://ec.europa.eu/environment/waste/prevention/pdf/report_waste.pdf)

[3] European Environmental Agency, 2010, The European Environment: State and Outlook 2010, Material Resources and Waste (http://www.eea.europa.eu/soer/europe/material-resources-and-waste)

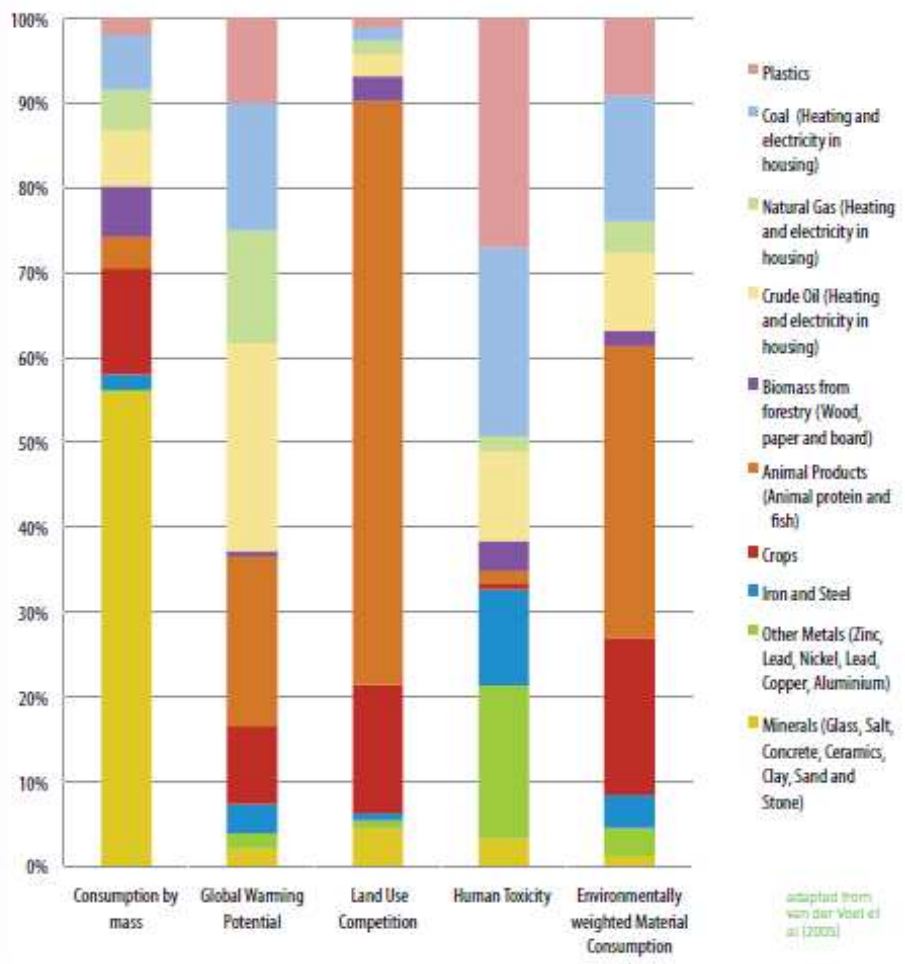
[4] BIO Intelligence Service et al., 2010, Plastic waste in the environment, for DG ENV (http://ec.europa.eu/environment/waste/studies/pdf/plastics.pdf)

2.1.2 Environmental impacts of products and materials

The quantification of environmental impacts associated with the life-cycle of products and materials is still in its early stages, with little data currently available at EU level, a high level of uncertainty on existing estimates and differing methodologies to estimate overall environmental impacts (especially with regard to the selection of relevant criteria and their respective weights).

A recent study on this topic was published by UNEP in 2010: "Assessing the environmental impacts of consumption and production – priority products and materials"[5]. Figure **2** below (extracted from the UNEP study) illustrates some key findings related to the environmental impacts of materials and products.

Figure 2: Relative contribution of groups of finished materials to total environmental impacts (total of the 10 material groups set at 100%), EU-27+Turkey, 2000 (Source: UNEP, 2010[5])



<u>Note</u>: More recent studies from these authors indicate that the results in this figure underestimate the contribution of biomass from Forestry (wood and paper and board products) to land use competition. Therefore the contribution of this material category to Land Use Competition may be higher than indicated in this figure. For further information, see van der Voet et al. (2009).

[5] UNEP, 2010, Assessing the environmental impacts of consumption and production – priority products and materials (http://www.unep.org/resourcepanel/documents/pdf/PriorityProductsAndMaterials_Report_Full.pdf)

There still is no consensus on the relative weight/importance of different environmental impact categories, but if equal weight is given to each impact category as identified in Figure **2**, the overall result is given in the last column ("Environmentally weighted Material Consumption").

According to the UNEP report, existing studies using mass-based and impact-based indicators converge on the following priority products and materials in terms of overall environmental impacts at the global level:

- **Agricultural goods and food** are identified as one of the most important drivers of environmental pressures, especially habitat change, climate change, water use and toxic emissions.
- Fossil fuel combustion is the most important source of most emissions-related impact categories, and **plastics** are important in terms of impacts among materials.
- **Metals**, in particular **iron, steel and aluminium** are also priority materials (although many metals have high impacts per kg compared to other materials, in view of the comparative size of their flows, iron, steel and aluminium are currently considered as having the highest overall impacts).

According to this analysis, mineral products, although they strongly dominate consumption by mass, would have a relatively limited overall environmental impact if one also takes into account their impacts on global warming, land use competition and human toxicity.

With regard to metals, the picture can be very different from one metal to another, taking into account in particular the fact that certain metals wastes are produced in very small quantities but are very hazardous (e.g. cadmium, mercury) and some metals are becoming relatively scarce resources for which improved recycling efficiency may also become a strategic issue from an economic point of view. These aspects are further discussed in Box 1 below.

At EU level, the following potential areas for future waste prevention and recycling policies have been identified:

- From a waste prevention policy perspective, hazardous waste and metal waste were considered as the priority waste streams, because of their high environmental impacts, and significant hidden material flows, followed by plastic waste[6].
- From a waste recycling perspective, plastics, biomass and metals were identified as the material streams with the highest potential for greenhouse gas (GHG) emission reductions[7].

[6] Arcadis, BIO Intelligence Service, VITO, and Umweltbundesamt, 2010, Analysis of the evolution of waste reduction and the scope of waste prevention, for DG ENV (http://eu-smr.eu/wasterp/)

[7] BIO Intelligence Service et al., 2011, Analysis of the key contributions to resource efficiency, for DG ENV (http://ec.europa.eu/environment/natres/pdf/Resource_Efficiency_Final.pdf)

Box 1: Overview of environmental and economic issues related to rare metals

A recent study indicates that metals with the most limited supply, of less than 50 years, of reserves are silver, indium, rhenium and tungsten.[8] These rare metals require expensive and environmentally damaging extraction and processing, and due to limited availability, have high price volatility. Some of them are very hazardous (e.g. cadmium, mercury). While it is difficult to estimate overall quantities of rare metals currently used and disposed of in the EU-27, silver and gallium can be considered as illustrative of the resource efficiency challenges faced in relation to rare metals.

In 2008, 21,300 tonnes of silver were produced, while existing reserves are estimated at 270,000 tonnes. With the current silver production rate, existing reserves will be exhausted within 13 years, or extraction will become exorbitantly expensive. Due to the wide variety of uses of silver, while recycling techniques do currently exist, collection and recovery of silver is dispersed and therefore difficult. The current recycling rate of silver is estimated to be between 30% and 50%.

In 2008, annual production of gallium was estimated at 111 tonnes; gallium is created as a by-product of aluminium and zinc production and reserves are estimated at over 1 Mt. Principal usages of gallium are in electronics, notably LEDs and solar panels, therefore, demand is anticipated to strongly increase in the future. While recycling techniques exist, the current recycling rate is only estimated at 20%.

Across 35 rare metals examined, recycling of production waste was relatively well developed; however, recycling of post-consumer rare-metal waste remained to be developed, aside from the platinum group of metals for which recycling techniques exist for principal usages of the metal.

2.1.3 Waste streams subject to quantitative management targets

Waste streams subject to quantitative management targets (on collection, reuse, recycling and other recovery options) are presented in Table 1 below.

[8] BIO Intelligence Service, 2010, Etude du potentiel de recyclage de certains métaux rares: Partie 1, for ADEME

Table 1: Waste management targets (expressed by weight) in the five waste stream Directives, the Waste Framework Directive and the Landfill Directive[9]

Legislative text	Year	Collection targets	Reuse targets	Recovery targets	Recycling targets
Batteries Directive (2006/66/EC)	2009	Requires establishment of collection systems	Mentions concept of reuse		100% of collected batteries
	2011				65% for lead-acid batteries; 75% nickel-cadmium and 50% for others (2)
	2012	25% (1) for portable batteries 100% for other batteries			
	2016	45% (1) for portable batteries 100% for other batteries			
Packaging Directive (94/62/EC)	2008	Requires establishment of collection systems	Re-use cited as priority	60%	55% min. – 80% max.; of which 50% metal, 60% glass, 60% paper/cardboard, 22.5% plastics, 15% wood
End-of-Life Vehicles Directive (2000/53/EC)	2005		See recycling target (3)	Vehicles to be recoverable to a minimum of 95%	Vehicles to be reusable and/or recyclable to a minimum of 85%
	2006	100%	See recycling target (3)	85%	80% including re-use
	2015	100%	See recycling target (3)	95%	85% including re-use
WEEE Directive (2002/96/EC)	2006	Min. 4 kg per inhabitant per year	See recycling target (3)	70-80% depending on category of WEEE	50-80% including reuse, depending on category of WEEE (2)
	2016 (recast	*45% of EEE placed on the*	*See recycling*	*70-85% depending on the*	*50-80% depending on category of*

[9] EC ,2011, Commission staff working document on the Thematic Strategy on the Prevention and Recycling of Waste (http://ec.europa.eu/environment/waste/pdf/Commission%20Working%20Doc.pdf)

Legislative text	Year	Collection targets	Reuse targets	Recovery targets	Recycling targets
	proposal)[10]	*market (first 4 years after entry into force) ;65% of EEE placed on the market (second 4 years after entry into force)*	*target* (3)	*category of WEEE (2)*	*WEEE (2)*
WFD (2008/98/EC)	2020	Separate collection (as of 2015)	See recycling target		50% including preparation for re-use for at least: paper, metal, plastic and glass in household waste
	2020	Not mentioned in relation to C&D waste	70% for Construction and Demolition (C&D) waste including preparation for re-use, recycling and other material recovery		
Landfill Directive (99/31/EC)	2006 or 2010 (4)	Encourages separate collection of biodegradable waste	N/A	Reduction to 75% of 1995 landfill levels	
	2009 or 2013(4)			Reduction to 50% of 1995 landfill levels	
	2016 or 2020 (4)			Reduction to 35% of 1995 landfill levels	

(1) Collection rate calculated based on sales in previous years
(2) Reuse-recovery-recycling targets for batteries and WEEE are based on amounts collected separately and fully sent for treatment (not the total amounts of waste generated)
(3) Requires reused equipment/vehicles to be waste before reuse
(4) For MS having a derogation (EE, UK, PL, CZ, LT, GR, IE, RO, BU, LV, SK)

[10] As agreed on Political Agreement, March 2011

The annual waste quantities produced in the EU corresponding to the waste streams subject to the above targets are estimated in the table below.

Table 2: Waste streams subject to quantitative targets in EU waste legislation

Type of waste	Quantity of waste generated	Quantity as a percentage of total waste generated
Waste batteries[11]	Approximately 800,000 tonnes/yr of automotive batteries, 190,000 tonnes/yr of industrial batteries and 160,000 tonnes/yr of portable batteries	0.04% of total waste generated in EU-27 in 2006
Packaging waste[12]	Approximately 83 Mt /yr	2.75% of total waste generated in EU-27 in 2006
ELVs[12]	Approximately 6 Mt/yr	0.20% of total waste generated in EU-27 in 2006
WEEE[13]	Estimated at between 6.7 Mt /yr[14] and 10.3 Mt /yr	Between 0.22% and 0.34% of total waste generated in EU-27 in 2006
Municipal Solid Waste (MSW)[15]	Approximately 200 Mt /year	7% of total waste generated in EU-27 in 2006
Construction and demolition (C&D) waste[16]	Estimated at between 510 and 970 Mt/yr	25% to 35% of total waste generated in EU-27

2.1.4 Examples of key waste streams not fully covered by quantitative targets or specific provisions

In order to illustrate some of the potential gaps in the legislative coverage of waste, several relevant examples have been identified and analysed in detail, as presented below.

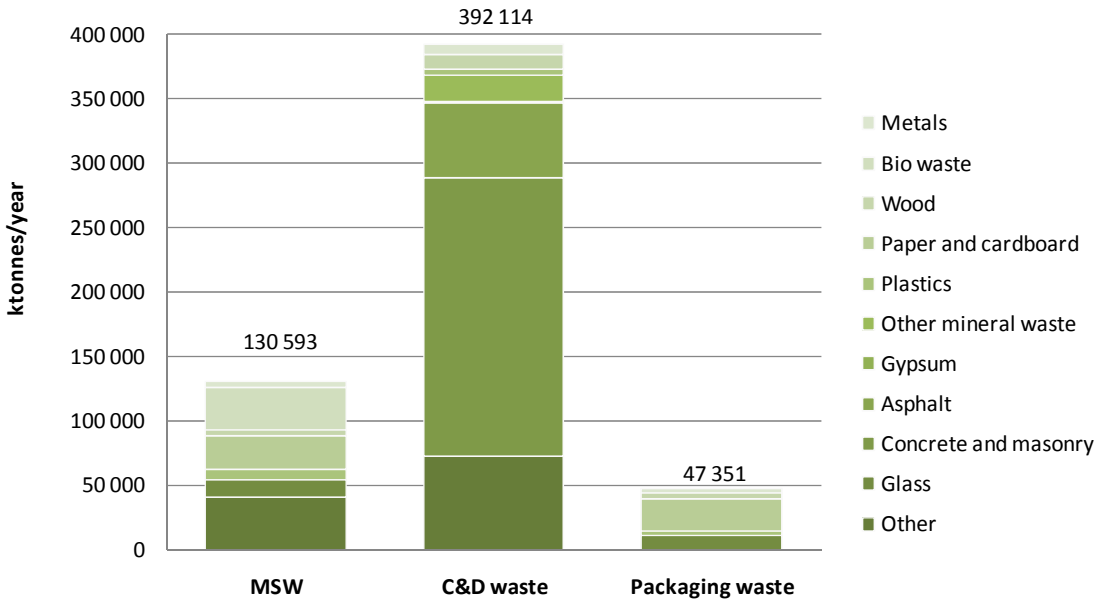
[11] Amount of batteries placed on the market annually in the EU-27; EC, 2003, Commission staff working paper on batteries and accumulators and spent batteries and accumulators: extended impact assessment
[12] As of 2007, on an annual basis; European Environmental Agency (2010) The European Environment: State and Outlook 2010, Material Resources and Waste (http://www.eea.europa.eu/soer/europe/material-resources-and-waste)
[13] As of 2005, on an annual basis; United Nations University, 2007, 2008 Review of Directive 2002/96 Waste Electrical and Electronic Equipment (WEEE)
[14] As of 2006, on an annual basis; European Environmental Agency (2010) The European Environment: State and Outlook 2010, Material Resources and Waste
[15] Eurostat ,2010, Environmental statistics and accounts in Europe (http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-32-10-283/EN/KS-32-10-283-EN.PDF)
[16] BIO Intelligence Service et al., 2010, Management of construction and demolition waste, for DG ENV (http://eu-smr.eu/cdw/)

Selection of examples

The examples of waste streams analysed in this section have been selected because of their significant environmental impacts (due to large volumes produced, hazardous properties and other types of impacts), their high potential for re-use and recovery and the fact that they are only partially covered by the binding targets on reuse and recovery at EU level. In addition to the data presented in the previous sections (current and future trends in waste generation, environmental impacts of materials and products), the following information has been taken into account for the choice of relevant examples:

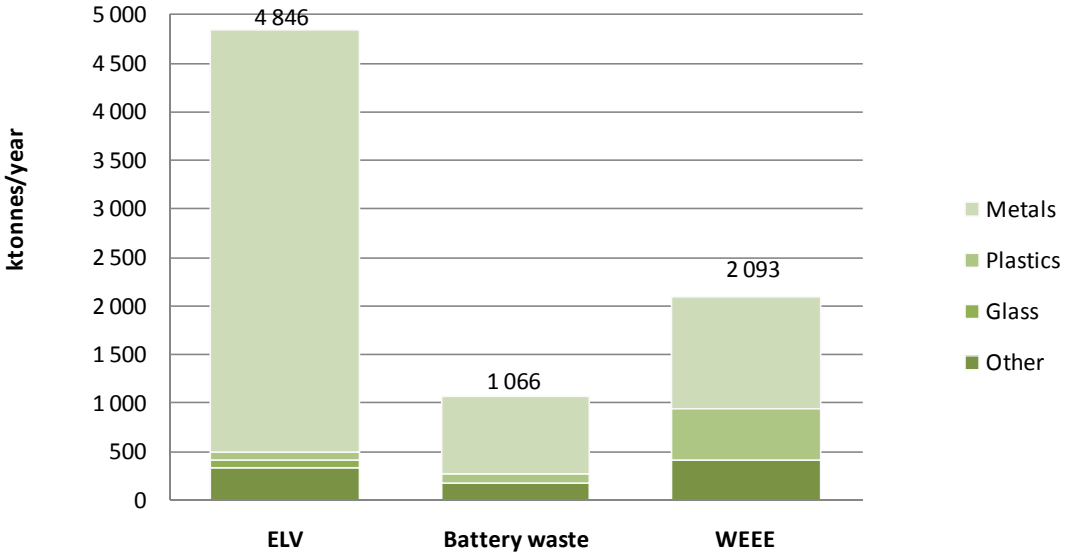
- The list of materials for which end-of-waste criteria are being developed; these materials were identified as priority streams due to their volume, potential for better waste management, resource substitution effectiveness, potential environmental benefits (including energy and greenhouse gas savings) as well as potential for EU harmonisation and legal compliance.[17]
- The findings of a recent study,[18] which provides an estimate of current amounts of waste materials that would be recycled if all current collection and reuse-recovery-recycling targets were met; these findings are illustrated in Figure 3 and Figure 4 below.

Figure 3: Estimates of waste quantities that would be recycled if all current targets were met – MSW, C&D waste and packaging waste[19]



[17] JRC,2010, Study on the selection of waste streams for end-of-life assessment (http://ftp.jrc.es/EURdoc/JRC58206.pdf)
[18] BIO Intelligence Service et al., 2011, Analysis of the key contributions to resource efficiency, for DG ENV

Figure 4: Estimates of waste quantities that would be recycled if all current targets were met – ELVs, battery waste and WEEE[19]



Finally, the three example waste streams selected for an in-depth analysis are **plastic waste, bio-waste** and **C&D waste**.

Plastics

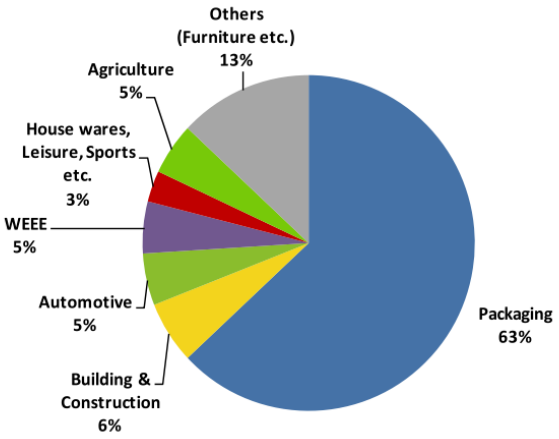
Amounts generated

Global production of plastics in 2009 was estimated at around 245 Mt, of which 25% was in the EU. In 2008, total quantities of post-consumer plastic waste in the EU-27, Norway and Switzerland was 24.9 Mt.[18] Packaging accounts for over half of total plastic waste and is either collected in separate packaging streams or in the Municipal Solid Waste. Plastics account for 20% of total packaging waste generated and have the lowest recycling rate compared to other packaging materials. While recent case studies have shown that the average weights of individual items of packaging have been decreasing, per capita quantities of packaging waste are increasing across the EU-27. The use of plastics in packaging material has increased by 40% between 1997 and 2006 while use of paper and cardboard only increased by 24% and glass and metals packaging increased by up to 2%.

Figure 5 provides details on the various sources of plastics waste.

[19] Data from EU based waste statistics and other sources, as presented in the report by BIO Intelligence Service et al., 2011, Analysis of the key contributions to resource efficiency, for DG ENV. All amounts are to be interpreted with caution since most of them are rough estimates.

Figure 5: Proportions of post-consumer plastic waste in EU-27, Norway and Switzerland by application, 2008[20]



A trend in the domain of plastics is the growth of bio-plastics, plastic substances derived from biomass sources instead of petroleum; some but not all bio-plastics are biodegradable. Bio-plastics consumption is estimated to be around 0.1-0.2% of total EU plastics consumption, and the global market for these types of plastics is growing very rapidly driven by landfill capacity, pressure from retailers, consumer demand and legislation based on concern over fossil-fuel dependence, greenhouse gas emissions, and marine litter. Worldwide production of bioplastics is estimated at 0.3 Mt per year, or approximately 0.1% of world plastic production capacity and estimated to be growing at a rate of up to 20% per year, hence representing a growing portion of plastics waste. Bioplastics are used primarily in packaging, loosefill packaging and waste collection bags, with market shares of 37%, 28% and 21% respectively.[20]

Environmental impacts

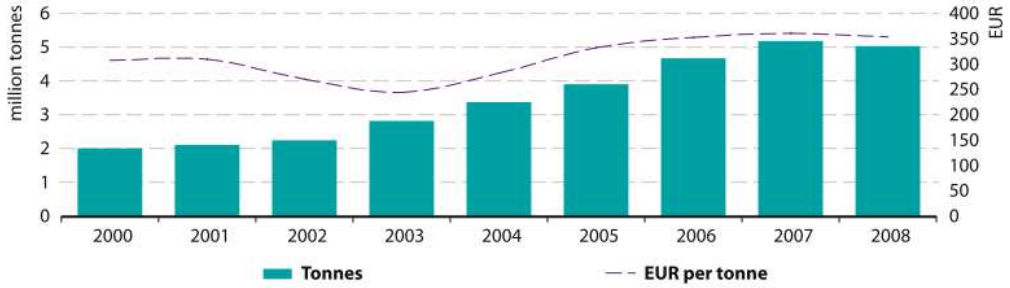
Plastic waste is usually non-biodegradable and hence can remain in the environment for a long time posing risks to human health and the environment and in practical terms, can be difficult to re-use or recycle. While thermoplastics[21] can be easily recycled or energy recovered, thermosettings[22] are much more difficult to recycle and few treatment facilities exist. Taking into account environmental impacts such as abiotic resource depletion, land use, global warming, human toxicity, and eutrophication, among other indicators, the Environmentally-weighted Material Consumption (EMC) assesses plastics as one of the most environmentally significant materials[3]. There is also concern about the impacts of plastics found in the marine environment, such as plastic fragments, plastic bags, and plastic bottles. While impacts are not fully understood, marine litter has a wide range of impacts on marine life, ranging from entanglement and ingestion of litter to the dispersion of invasive species. Specifically, plastic transforms into small, microscopic particles, widely distributed in the oceans, causing further damage to ecosystems. The environmental impacts of bioplastics are not yet fully understood.

[20] BIO Intelligence Service et al., 2011, Plastic waste in the environment, for DG ENV (http://ec.europa.eu/environment/waste/studies/pdf/plastics.pdf)
[21] e.g. polyethylene and polypropylene ; polymers which can be remelted and remoulded
[22] e.g. Polyester fibreglass systems and polyimides ; polymers which cannot be remelted or reshaped after curing

Potential for improved waste management

Multiple end-of-life options exist for plastic waste, including recycling, disposal and incineration with or without energy recovery. While recycling is expected to grow in absolute terms through technological innovation, it may not keep up to deal with the expected growth of plastic waste, seeing current trends; hence other solutions are needed.[20] As shown in Figure 6, both the volume and price index of plastic waste materials has increased over time, indicating not only the importance of the waste stream in terms of quantity but also the importance of plastics as a material for reuse, and the importance of market dynamics to increase their recycling.[23]

Figure 6: Volume and price index of plastic waste materials, EU-27 (million tonnes and Euros)[1]



Source: Environmental Data Centre on Waste

A study on European waste generation projections to 2035 assessed the introduction of strong policies to extend recycling and found plastic as having the largest potential for reducing the environmental impacts of waste.[24] The same study monetised the environmental impacts of greenhouse gas (GHG) emissions and other air emissions by waste stream and treatment option and found the one highest specific impact per kilogram of waste for the incineration of plastic waste.

As of 2008, the plastics recycling rate was 21.3% in the EU-27, helping to drive total recovery of plastics (energy recovery and recycling) to 51.3%. Plastic waste from packaging such as polyethylene terephthalate (PET) bottles and polyethylene (PE) containers are one of the main sources driving the waste plastic recycling industry.

Extent of coverage by current targets on recycling

Current reuse/recovery/recycling targets relevant for plastic waste are included in the Packaging Directive (covering plastic in packaging from MSW and industrial waste) and in the WFD (covering plastic in MSW), as detailed in Table 1. However, while two Directives provide explicit targets for plastics, plastic waste is indirectly addressed across six waste streams currently subject to recycling targets as shown in Figure 3 and Figure 4 (see page 28).

[23] Eurostat ,2010, Environmental statistics and accounts in Europe (http://epp.eurostat.ec.europa.eu/cache/ITY_OFFPUB/KS-32-10-283/EN/KS-32-10-283-EN.PDF)

[24] FORWAST,2010, Documentation of the contribution analysis and uncertainty assessment. Results interpretation identifying priority material flows and wastes for waste prevention, recycling and choice of waste treatment options. Policy recommendations. (http://forwast.brgm.fr/Documents/Deliverables/Forwast_D63.pdf)

It can be estimated that approximately 16 Mt/year of plastic waste could be recycled if all current recycling targets were met, across the waste streams of MSW, C&D waste, ELV, Packaging, Battery and WEEE[18]; however this figure may be overestimated since there is some uncertainty regarding the amounts of packaging waste included in MSW statistics. The waste streams subject to quantitative targets and including the largest quantities of plastics are MSW, packaging waste and C&D waste.

Comparing the 16 Mt corresponding to the achievement of EU waste management targets with the 24.9 Mt of plastic waste produced in the EU 2008, indicates there is approximately another 9 Mt of plastics waste not specifically covered by mandatory reuse/recovery targets (representing approximately 37% of total EU plastic waste). This 9 Mt primarily represents plastics found in furniture and equipment (other than EEE).

Bio-waste

Amounts generated

Bio-waste, as defined in the WFD, includes garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises as well as similar waste from food processing industry. Forestry and agriculture residue is not considered bio-waste. Bio-waste is different from the broader term "biodegradable waste" which includes other biodegradable materials such as wood, paper, cardboard, and sewage sludge. In the EU-27, between 118 and 138 Mt of bio-waste are produced every year; approximately 88 Mt of which is municipal waste.[25] Bio-waste generation is projected to increase by around 10% by 2020. A recent study estimated the annual generation of food waste in the EU-27 as approximately 89 Mt, representing roughly 70% of bio-waste produced in the EU-27.[26] Approximately 30% to 40% of the mass of municipal solid waste produced in the EU-27 is bio-waste.

Environmental impacts

The main environmental impact of bio-waste is the production of methane in landfills, which represented approximately 3% of total greenhouse gas emissions for the EU-15 in 1995. Approximately 70% of bio-waste is food waste; a recent study estimates the total environmental impact per tonne of food waste across the manufacturing/processing, wholesale/resale, catering, and households sectors as 1.9t CO_2 eq./t. Taking into account population growth and growth in disposable income, food waste is expected to lead to an estimated additional 70.2 million tonnes of CO_2 equivalent emissions in 2020, in comparison with 2006. Bio-gasification and incineration of food waste have been estimated as key potential areas for optimising waste treatment to reduce the overall environmental impacts of such waste.[24]

[25] EC, 2010, Communication on future steps in bio-waste management in the European Union (http://ec.europa.eu/environment/waste/compost/pdf/com_biowaste.pdf)
[26] BIO Intelligence Service et al., 2010, Preparatory study on food waste across EU 27, for DG ENV (http://ec.europa.eu/environment/eussd/pdf/bio_foodwaste_report.pdf)

Environmental impacts of bio-waste are strongly based on the treatment method chosen. Primary methods used are composting, anaerobic digestion, landfilling and incineration. The landfilling and incineration of food waste has been assessed as having one of the highest specific environmental impacts per kilogram of waste when a comparison was made across waste types and treatment options.[24] The environmental impacts of each of the four main potential treatment methods in terms of emissions are:

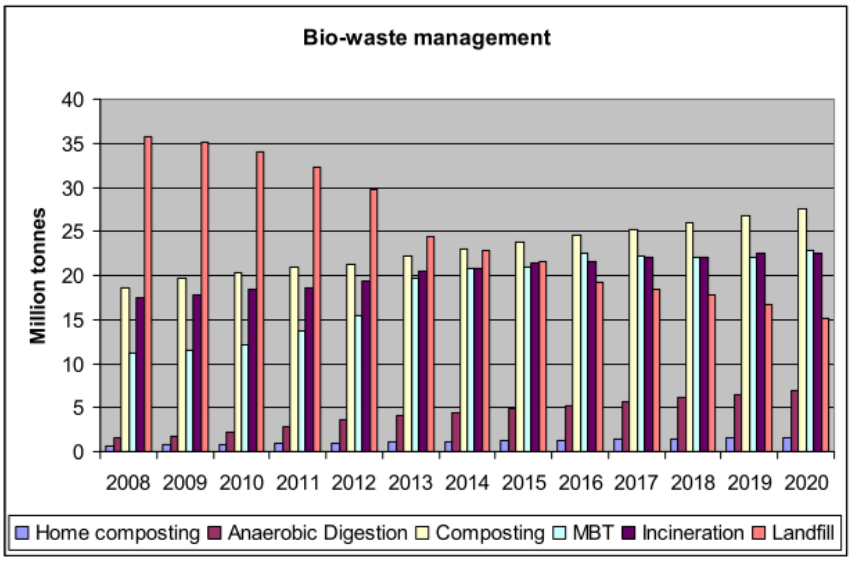
- **Composting:** GHG emissions from the decomposition of organic matter, nitrous oxide and methane
- **Anaerobic Digestion:** Emissions of small amounts of fugitive emissions of method from installations and emissions of GHG and nitrogen oxide in the process of combustion of biogas for energy production
- **Landfilling:** Significant amounts of emissions of gases consisting of methane, carbon dioxide, nitrogen oxide and ammonia, and traces of harmful substances, pollution of soil and groundwater
- **Incineration:** Significant emissions of biogenic CO_2 as well as variety of harmful air pollutants including dust and particulate matters, dioxins, nitrogen oxide, sulphur dioxide, acids, carbon monoxide, organic volatile compounds and heavy metals [27].

Potential for improved waste management

Bio-waste primarily has the potential to contribute to the generation of compost to fertilise soils and the generation of energy via anaerobic digestion. Landfilling of bio-waste represents a loss of resources. As of 2008, it was estimated that the market for quality compost could be increased by a factor of 2.6 to reach approximately 28 million tonnes, thereby helping to improve the quality of 3% to 7% of depleted agricultural soils and address the broader problem of degrading soil quality in Europe[25]. Maximising composting could also substitute for 10% of phosphate fertilisers, 9% of potassium fertilisers and 8% of lime fertilisers. Approximately one-third of the EU 2020 target to use renewable energy in transport could be met by using the biogas produced from bio-waste as vehicle fuel; if all bio-waste produced in the EU in 2020 was treated through anaerobic digestion and the gas used by public vehicle fleets, the potential gain is estimated at 13 Mt CO_2 equivalent. Emissions ranging between 10 Mt and 50 Mt CO_2 equivalent could be avoided by more prevention and biological treatment of bio-waste, representing 0.4% to 2.3% of EU GHG emissions in 2005. Routing bio-waste towards composting and energy production could represent between 4% and 23% of the 2020 EU target of a 10% reduction of non ETS GHG emissions as compared to 2005 emissions.[27]

[27] EC ,2010, Commission staff working document accompanying the Communication from the Commission On future steps in bio-waste management in the European Union (http://ec.europa.eu/environment/waste/compost/pdf/sec_biowaste.pdf)

Figure 7: Baseline scenario – projected evolution of bio-waste treatment for the EU-27[27]



Currently, a variety of approaches for managing bio-waste are used by Member States (MS):

- Countries relying heavily on incineration of waste diverted from landfills, coupled with a high level of material recovery and often advanced strategies promoting biological treatment of waste
- Countries with high material recovery rates but relatively little incineration, with very high composting rates
- Countries relying on landfills, where diversion of waste from landfills remains a major challenge due to lack of alternatives.[25]

In the EU-27, on average 40% of bio-waste is still landfilled, with up to 100% landfilled in some MS.

Extent of coverage by current targets on recycling

While the Landfill Directive sets targets for reductions in biodegradable waste, as illustrated in Table 1 (on page 24), these targets do not involve any provisions for prevention and recycling specific to bio-waste. The WFD sets out a clear strategy towards the separate collection and treatment of MSW, however it does not include any specific provisions related to bio-waste management.

It can be roughly estimated that 33.5 Mt/year of bio-waste from MSW could be recycled if current recycling targets were met[18]. This represents less than half of the amount of bio-waste generated in MSW (88 Mt/year). This also represents only a fraction of the total amount of bio-waste generated in the EU-27, estimated between 118 and 138 Mt/year. Bio-waste not covered by current targets appears to be generated not only by households but also by the food industry supply chain such as restaurants, caterers, retail premises and food processing plants.

Construction & demolition waste

Construction and demolition (C&D) waste is estimated to account for approximately 25% to 35% of waste produced in the EU. Estimates of C&D waste generated in the EU-27 range from 510 Mt to 970 Mt/year[16]. Some MS have not reported any figures, while others appear to include excavation material in their figures. A study taking into account varying reporting practices for C&D waste has estimated waste generation at 535 Mt/year.[28] C&D waste is produced by activities such as construction, total or partial demolition of buildings and other civil engineering activities, road planning and maintenance. Materials found in the C&D waste stream mainly include: concrete, bricks, gypsum, wood, glass, metal, plastic, solvents, asbestos and excavated soil. The most commonly recycled materials in this waste stream are concrete, bricks, tiles and asphalt. C&D waste is primarily defined by the activity from which it originates; however, there is some debate as to whether the stream should be defined by origin or by material content.

Environmental impacts

C&D waste was identified as a priority waste stream in terms of environmental impacts in the Austrian Waste Prevention and Recycling Strategy due to its high mass flow. In 2008, the Flemish Waste Agency found that construction and demolition has the second highest impact of all waste streams examined, just after the mixed waste.[29]

Potential for improved waste management

C&D waste has a high potential for re-use and recovery, which is not currently taken advantage of, in spite of the fact that the technology for the separation and recovery of C&D waste is well-established and generally inexpensive. High rates of C&D recycling could save large quantities of virgin resources. It can be assumed that within the C&D waste stream a majority of the recovered products are recycled aggregates that replace virgin aggregates; recycled aggregates were estimated at 7% of aggregates used in 2006, hence indicating large room for improvement. Reuse, recycling and recovery of C&D waste, estimated at 47% in the EU-27 in 2006, represent around 4% to 14% of the mineral material placed on the market; this percentage could increase to between 7% and 21% if the 70% target in the WFD was met.

Currently levels of recycling and reuse vary greatly among MS. The margin for improvement appears to be large in some MS; however, there is also a large degree of inconsistency in the management systems and definitions used, making an effective comparison among MS difficult. Some MS dispose of C&D waste to a large extent in landfills, without removing hazardous components, while other MS, such as Denmark and the Netherlands achieve 90% recycling rate[28]. Furthermore, there is a lack of harmonisation and compatibility between MS when calculating recycling and reuse rates for C&D waste. Rates are very dependent on boundary

[28] BIO Intelligence Service et al., 2011, Management of construction and demolition waste, for DG ENV (http://www.eu-smr.eu/cdw/docs/BIO_Construction%20and%20Demolition%20Waste_Final%20report_09022011.pdf)

[29] Arcadis, BIO Intelligence Service, VITO, and Umweltbundesamt, 2010, Analysis of the evolution of waste reduction and the scope of waste prevention, for DG ENV (http://eu-smr.eu/wasterp/)

conditions established and those conditions differ greatly among MS, for example the definitions of "waste", "non-waste" and "end-of-waste". A recent study calculated an average recycling rate of C&D waste for the EU-27 of 46%, which is aligned with estimates proposed by experts and literature which range from 30% to 60%.[28]

Extent of coverage by current targets on recycling

C&D waste is only directly covered by one recycling target, found in the WFD (see Table 1 on page 24). While the 70% target encourages reuse, recycling and recovery, the scope of what can be included within the target remains uncertain and problematic. A study on the European List of Waste concluded that the definition of C&D waste based on the European List of Waste is not sufficient to account for all C&D waste targeted in Article 11 of the WFD and that additional guidance on reporting of recycling targets is needed to ensure data comparability.[30]

Additionally, this target does not provide any sub-targets for specific materials within the C&D waste stream, which may have higher environmental impacts than other materials found in the waste stream. As the 70% target could be achieved by recovery of only the mineral fraction of the C&D waste stream, material-based targets could encourage the recovery and recycling of more problematic materials found in the waste stream such as gypsum, insulating foam and plastic, for which there exists less of an economic motivation for reuse.

It can be estimated that approximately 390 Mt of C&D waste, comprised of metals, glass, concrete and masonry, asphalt, gypsum, other mineral waste, plastics, wood and other wastes could be recycled if the current target in the WFD was met[18].

Other waste streams with potentially inadequate coverage

In addition to the three main examples analysed previously, a few other waste streams have been identified which may deserve further analysis. These waste streams are currently not covered by EU waste stream related Directives, although some MS have put in place prevention and recycling schemes. It seems that significant environmental benefits could be achieved if these waste streams and materials were better managed at a European level. These are:

- **Furniture waste** (includes significant volumes of wood and plastic waste, significant potential for reuse and recovery, some MS (e.g. France) are in the process of implementing mandatory collection and treatment schemes)
- **Textile waste** (increasing volumes in household waste, significant potential for reuse and recovery)
- **Waste pharmaceuticals from households** (high environmental impacts to water ecosystems, potential impacts on human health, some MS have already implemented mandatory collection and treatment schemes)

[30] Okopol, 2008, Review of the European List of Waste, for DG ENV (http://ec.europa.eu/environment/waste/pdf/low_review_oekopol.pdf)

- **Hazardous waste from households** (high environmental impacts due to hazardous properties; some MS have already implemented or are in the process of implementing mandatory collection and treatment schemes)
- **Unsolicited printed papers** (significant volumes, some MS such as France have already implemented mandatory collection and treatment schemes)
- **Nanowaste**, i.e. waste that contains materials with nanoscale dimensions (potentially large quantities and hazardous properties, although there is still a lot of uncertainty on the associated risks)
- **Certain rare metals such as silver, indium, rhenium and tungsten** which are present in various waste streams (post-consumer recycling capacities not sufficiently developed to address future resource exhaustion issues).

Recommendations

This study identified several examples demonstrating some gaps in the scope of EU waste legislation coverage. It would be worth performing a deeper analysis, in order to inform future policy development in this area. This would require a comprehensive assessment of waste streams of greatest environmental concern, based on a quantification of life-cycle impacts and analysis of current waste management options.

2.2 Drivers for resource efficiency

This section identifies the drivers for resource efficiency, and the extent to which they are included in the current waste stream related Directives. Achieving a better coherence of waste legislation would involve having a common set of drivers across the various policy instruments. In this section, only the design and content of the Directives is investigated, not the actual implementation of existing legal provisions.

2.2.1 Waste hierarchy

The waste hierarchy lays down a priority order of what generally constitutes the best overall environmental option in policies related to end-of-life management. Provisions related to the waste hierarchy, as presented in the 2008 WFD, can be a key driver for resource efficiency:

a) prevention;
b) preparing for re-use;
c) recycling;
d) other recovery, e.g. energy recovery; and
e) disposal.

Waste stream Directives, older than the 2008 WFD, do not systematically adopt the same waste hierarchy. In general, these do not sufficiently give priority to waste prevention over recycling and other forms of recovery and they do not sufficiently integrate life-cycle thinking.

Although the hierarchy set out in the WFD implicitly applies to all waste streams, having a common wording in all Directives would improve clarity, especially since the Directives may have different legal bases, for example, the Packaging Directive has an objective of ensuring the functioning of the internal market. Given the importance of this hierarchy for determining end-of-life options, a realignment of the priorities in the waste stream Directives with the WFD would be useful.

In the case of the Packaging Directive, there is some uncertainty among stakeholders as to whether and how the waste hierarchy set out in the WFD would apply or not to this waste stream, because of the different legal bases of both Directives. While the Packaging Directive is based on Art. 95 (establishment and functioning of the internal market) of the former EU Treaty, the WFD is based on Art. 175 (environmental protection). During the stakeholder consultation, it appeared that the legal base of the Packaging Directive was potentially a key issue which would need to be reviewed in order to improve clarity and coherence with other waste legislation[31].

2.2.2 Waste prevention

Waste prevention is a horizontal action applicable to all steps of the life cycle of products. It cannot be limited to one stage, however, the higher stage in the material chain the prevention measures are taken, the more effect they have on all subsequent stages. For this reason the design and pre-design phases have the most impact on the total of waste prevention effects.

Prevention means measures taken before a substance, material or product becomes waste and covers two main types of actions: reducing the quantity of waste (increasing the life span of products and/or re-use of products) and reducing the content of harmful substances in materials and products.

Prevention for reducing waste quantities

Overall, it seems that waste prevention provisions in the existing Directives are more focused on reducing the hazardousness of waste than the overall quantities of waste.

In terms of quantity, only the Packaging and ELV Directives set out articles about actions to be conducted in order to prevent waste. At the same time, both the ELV and WEEE Directives contain reuse as an element of their targets.

With regard to packaging, although there has been no actual reduction in the quantity of packaging materials, there has been an increase in the material efficiency of packaging materials. Evidence from the packaging industry shows that considerable reductions in weight have been achieved since the 1990s, although the evolution in the last few years tends to show that technical limits of lightweighting are being reached, as highlighted in Table 3. The packaging manufacturers and recyclers highlighted that there are already natural drivers for packaging waste prevention, in particular due to production costs and increasing awareness of consumers

[31] Unlike the Packaging Directive, the ELV and WEEE Directives are only based on Art. 175 of the former EU Treaty while the Batteries Directives is based on both Art. 95 and 175.Given the Packaging Directive's legal base, MS have less flexibility (when compared to the ELV and WEEE Directives) in terms of the adoption of national measures to deal with packaging.

about over-packaging and environmental impacts of packaging; however, it was recognised that there is still room for improvement.

Table 3: Evolution of packaging weight

Type of packaging	1950s	1960s	1970s	1990s	2000	2008	Per centage[32]
Washing-up liquid bottle (1 litre)	–	–	120g	67g	50g	43g	64%
Soup can (400g)	90g	–	69g	57g	55g	49g	46%
Yoghurt pot (165g)	–	12g	7g	5g	–	4g	67%
Plastics fizzy drinks bottle (2 litre)	–	–	58g	–	43g	40g	31%
Metal drinks can (330ml)	–	60g	–	21g	15g	14g	77%
Glass beer bottle (275g)	–	–	450g	–	325g	176g	61%
Glass milk bottle (1 pint)	538g	–	397g	230g	–	186g	65%

Current provisions in the waste stream Directives on reducing quantity are non-binding and too broad to create incentives for an efficient prevention. More emphasis could be put on this aspect in the legislation in line with the approach taken by the WFD. The latter contains several provisions related to prevention such as reporting of action in the EU on waste generation and prevention, the development of an EU action plan, waste prevention objectives and waste prevention programmes at the MS level, and qualitative or quantitative benchmarks for waste prevention measures to be adopted by MS in order to monitor progress.

Table 4 below provides some examples of waste prevention measures and estimates of their waste reduction potential. Although these estimates might appear relatively optimistic in certain cases, they show that overall there is significant margin for improvement in terms of waste quantities reduction.

Additional provisions to encourage waste prevention in each of the waste stream-related Directives could include for example:

- Waste reduction targets (e.g. reduction % versus current levels or year on year reduction %, based on total amounts or per inhabitant); several MS have already introduced or are planning to introduce such targets, in general focusing on municipal waste
- Maximum waste production targets (total amounts produced per year or the amounts per capita per year)
- "Preparation for re-use" targets
- Targets on minimum % of recycled materials to be contained in new products
- Ecodesign provisions relevant to each waste stream, which can play a critical role in waste prevention (further discussed in Section 2.2.3 below).

[32] The per cent change measures the weight reduction in 2008 compared with the first year of data reporting for the product in the table

Table 4: Examples of potential waste reduction measures at EU level (Source: ACR+[33])

Actions for the 5 flows	Generation (kg/hab./y)	Potential waste reduction (kg/capita/y)
1. Bio-waste	220	40
Greenscaping	90	10
Smart gardening		
Act against food waste	30	10
2. Packaging	150	25
Encouraging refillable/returnable bottles	35	12
Promoting tap water	6	2
Encouraging reusable bags	2	1
Fight against excess packaging	107	10
3. Paper waste	100	15
Reducing unwanted and unaddressed mail	15	4
Encourage dematerialisation through ICT	75	9
Reducing kitchen, tissue and towel paper	10	2
4. Bulky waste	52	12
Promote clothes & other textile waste prevention	15	4
Promote furniture waste prevention	20	4
Promote WEEE prevention	17	4
5. Nappies and other wastes	78	8
Swap to reusable nappies and incontinence pads	18	2
Other municipal waste prevention strategies	60	6

A more comprehensive list of potential additional provisions to encourage waste prevention is provided in recent report for DG ENV on "Analysis of the evolution of waste reduction and the scope of waste prevention".

[33] ACR+, Quantitative waste prevention benchmarks (Extracts from the ACR+ guide on waste prevention) (http://www.arc-cat.net/ca/publicacions/pdf/ccr/setmanaprevencio09/ponencies/3%20Ponencia%20JP%20Hannequart.pdf)

Preventing and reducing the harmfulness of waste

The Packaging, ELV, Batteries and RoHS Directives all contain requirements for the reduction of hazardous substances within the relevant products. Table 5 below summarises the potential contribution of waste prevention to resource efficiency. The prevention options assessed include the impacts of the RoHS Directive and the full range of re-use and preparation for re-use strategies (e.g. refurbishment, repair, remanufacturing, servicing, etc.).

Table 5: Potential material savings from waste prevention[18]

Measures	Assumed impact on material savings (avoided quantities of waste)
Restriction of hazardous substances (RoHS Directive)	89 800 t of lead, 4 300 t of cadmium, 537 t of hexavalent chromium, 22 t of mercury, 12 600 t of octa-BDE, 40 000 t of non-reacted TBBPA, 210 tonnes of HBCDD, 29 000 t of DEHP and 1.5 t of beryllium oxide
Preparation for re-use, re-use, repair, remanufacturing and sharing/servicing	10% of WEEE 10% of registered vehicles

In spite of significant progress in reducing the amounts of hazardous substances in waste/products (e.g. through the RoHS Directive), there is still significant potential for further improvement. For example, the Commission's impact assessment of the WEEE Directive recast[34] highlights the fact that considerable amounts of hazardous substances not covered by RoHS are still being used in EEE, including: non-reacted TBBPA[35], HBCDD[36], DEHP[37] and beryllium oxide. It is estimated that 40,000 t of non-reacted TBBPA, 210 t of HBCDD, 29 000 t of DEHP and 1.5 t of beryllium oxide could be annually removed from EEE[34]. The levels of presence of the current list of hazardous substances could also be reduced further: the impact assessment mentions that 50,000 t of lead in cathode ray tubes, 4.3 t of mercury in lamps and 2.8 t of mercury in LCD panels are still put on the market every year.

2.2.3 Product design

Ecodesign requirements are probably the most important driver, with high potential for impact reduction since it takes places at a stage where there are still a lot of possibilities to minimise potential impacts. The main approaches to foster resource efficiency in the area of design are:

- Design for longevity and reusability – In most cases, increasing the lifetime of a product saves resources and reduces waste generation, although in certain cases it may not be environmentally beneficial to increase the longevity of products when more recent

[34] EC, 2008, Commission staff working paper accompanying the proposal for the Directive of the European Parliament and of the Council on WEEE (recast)
[35] Tetrabromobisphenol-A, a flame retardant
[36] Hexabromocyclododecane, a flame retardant
[37] Bis(2-ethylhexylphthalate), a PVC (poly-vinyl chloride) plasticiser

products have significantly lower environmental impacts because of advanced technologies (e.g. cars)

- Product lightweighting (i.e. dematerialisation; miniaturisation) – Use of lighter materials is expected to decrease environmental impacts at the end-of-life through a reduction of waste volumes, however there may be some exceptions where lighter materials used for substitution have a much higher environmental impact per kilogram.
- Design for recyclability (i.e. using recyclable material; using recycled material; minimising number of parts involved in product components; minimising the number of different types of material; marking parts for easier identification; eliminating labels or product components that have to be removed before recycling; making the product easy to disassemble).

While the first two approaches contribute to waste prevention objectives (discussed in the previous section), the latter contributes to the optimisation of recycling.

Some of the Directives specify requirements for the design and production of products that facilitate reuse, preparation for reuse or recovery. For instance, the WEEE Directive contains clauses intended to encourage the design and production of EEE, which facilitates dismantling and recovery. However, such requirements are not present in all waste stream Directives and not harmonised, with significant differences in their transposition across MS; they are still very weak when considering the potential environmental benefits that could be achieved by promoting ecodesign more efficiently. In addition, EU waste policy could probably address potential environmental issues resulting from planned obsolescence[38] strategies adopted by certain manufacturers, especially in the case of WEEE, as well as certain other design strategies encouraging a high consumption of consumables (e.g. printer cartridges, coffee capsules). An example of good practice initiative to improve the design of plastic bottles is presented in Box 2 below.

Box 2: Initiative for 100% PET recyclability

UNESDA (Union of European non-alcoholic beverage associations) and EFBW (European Federation of Bottled Waters) propose to put in place measures to improve the recycling of PET bottles and achieve a recycling rate of 100% in closed loop by 2012. However, this objective requires that the used PET is of excellent quality. Barriers, additives, opaque colouring, etc. can deteriorate the quality, negatively impacting on closed loop bottle recycling. Recommendations are therefore made to follow the "Design for recycling guidelines"[39] published by EPBP (European PET Bottle Platform) in order to improve the recyclability of PET bottles. Members of the two organisations are asked to review their PET bottle specifications and to solve issues of non-compatibility over the next two years.

These recycling guidelines could be an important step forward in terms of resource efficiency.

[38] Policy of deliberately planning or designing a product with a limited useful life, so it will become obsolete or non-functional after a certain period (this concept was first developed in the 1920s)

[39] EPBP, 2010, Design for recycling guidelines PET bottles (http://www.petbottleplatform.eu/downloads/public/20100212_EPBP_recycling_guidelines_PET_bottles_(website).pdf)

Following are some other specific issues:

- In the Batteries Directive, a greater focus is needed on the removability clause, as this is particularly important to being able to recycle batteries; many producers cite an exemption.
- In the Packaging Directive, the imprecise formulation of the Essential Requirements in terms of the practical application of recyclability poses challenges in implementation and makes measurement of compliance difficult. While the Essential Requirements should be taken into account across the life cycle of the product, starting with product design, MS and producers report a lack of clarity in practice on how and when they should be taken into account in the production process. It was also pointed out that packaging design should be better addressed at the product design stage (rather than as a later stage), since in many cases the contamination of packaging waste by the contained products is an issue for recycling.
- In addition to the ELV Directive, the automobile industry is covered by Directive 2005/64/EC[40] and Directive 2009/1/EC[41] on reusability, recyclability and recoverability. This legislation requires a Certificate of Compliance prepared during vehicle type approval. No similar requirements exist in the other waste stream Directives.

On the other hand, ecodesign requirements for the products of concern (packaging, EEE, batteries, cars[42]) are not fully addressed by the Ecodesign Directive (2009/125/EC). The aim of the Ecodesign Directive is to improve the environmental performance of (energy-using and energy-related) products put on the market in the EU by setting ecodesign requirements for their design. The Ecodesign Directive identifies parameters, such as raw materials selection, packaging, and possibilities for preparation for re-use, recycling and recovery, which could be considered. These parameters could have significant impacts on resource savings if considered within the implementing measures[43]. However, actual contributions of this Directive to resource use and efficiency have not been significant for two main reasons:

1) The Directive is quite recent to assess its contribution. The first implementing measures with ecodesign requirements were only adopted in 2008; the Directive entered into force in 2005 and the preparatory studies for the first product groups to be considered for ecodesign requirements were launched in 2006/2007. So far only nine of these product groups have resulted in implementing measures.
2) The methodology for assessing products focuses on energy efficiency; although each preparatory study considers the whole life cycle, the environmental impacts of other phases are seen as minor compared to the use-phase. As a result none of the

[40] DIRECTIVE 2005/64/EC of 26 October 2005 on the type-approval of motor vehicles with regard to their reusability, recyclability and recoverability and amending Council Directive 70/156/EEC

[41] COMMISSION DIRECTIVE 2009/1/EC of 7 January 2009 amending, for the purposes of its adaptation to technical progress, Directive 2005/64/EC

[42] Transport products are presently not covered by the Ecodesign Directive.

[43] BIO Intelligence Service, 2010, Technical support to identify product categories with significant environmental impact and with potential for improvement by making use of ecodesign measures, for DG ENV

implementing measures relate to material efficiency[44]. The regulations that have entered into force show no direct contributions to material savings, except in the case of domestic lighting (where specific aspects such as use of glass, use of plastic and mercury content have been considered). One reason behind this is also the choice of products targeted initially by the Directive are those where a significant potential for energy efficiency exists.

It would therefore seem relevant to include more specific ecodesign requirements in the waste stream Directives[45], focusing on design characteristics influencing waste prevention and improved recyclability of the relevant waste streams, or to include more waste specific requirements in the policies targeting product design such as the Ecodesign Directive.

2.2.4 Waste collection, reuse and recovery

Definition of current targets

Mandatory targets on waste collection, re-use, preparation for re-use and recovery are key drivers for resource efficiency (see Table 1 on page 24 for the details of existing targets). However, there are some issues in the definition of existing targets that represent obstacles to the optimal achievement of existing targets, in particular:

- The targets vary in terms of the processes covered and the definitions of these processes (re-use, preparation for re-use, recovery, recycling, etc.)
- The levels of achievement to be delivered differ, as well as the base years
- There are overlaps between the waste stream Directives in terms of data reporting, e.g. between the Batteries and WEEE Directives and between the Batteries and ELV Directives (difficulty in understanding what collection and recycling targets waste batteries inside WEEE or inside ELVs count towards)[46]

Although the specificities of each waste stream have to be taken into account when setting the targets, this high variability in the criteria used to define the targets means that there is no possible comparison between the Directives in terms of targets' achievement. Additionally, it also entails different approaches to the collection of data that potentially adds administrative burden.

With regard to collection targets, different approaches have been used across the Directives:

- The Battery, ELV and WEEE Directives set collection targets and re-use-recovery targets based on collected waste quantities
- The Packaging Directive has no collection target but the recycling-recovery targets are based on total packaging waste generated.

[44] Helena Mälkki, H., Vanhanen, H., Heiskanen, J.,2010, Product specific EuP studies of LOTs 15 to 18 relevancy of other environmental aspects besides the use phase energy consumption of products. Norden.
[45] WEEE has clear provisions on ecodesign but they are rarely put into practice.
[46] However, a Q&A document on the Batteries Directive has been published by the EC provides some guidance on how to take into account the links between the Batteries Directive and other legislation (http://ec.europa.eu/environment/waste/batteries/pdf/qa.pdf)

For waste streams where it is possible to accurately measure the total amount of waste produced, it seems more relevant to base reuse-recovery targets on total collected amounts since it provides a better picture of waste management performances and simplifies the understanding of monitoring data. However, for waste streams such as WEEE and batteries, it is relatively difficult to accurately assess the total amount of waste generated at present; therefore it seems more relevant to keep the two step approach: 1) improving the collection rate and 2) improving reuse-recovery rates. This two level approach also enables to obtain more accurate reuse-recovery data in the short term and ensure that what is collected is properly managed. In the longer term, once the amounts of waste generated are better characterised (or to encourage businesses to develop reliable estimates), an approach similar to the Packaging Directive could be adopted.

On the legal aspect of targets, the solutions to improve resource efficiency would be to realign the priorities in the waste stream Directives with the waste hierarchy set out in the WFD and to adopt a common approach to target setting in order to enable an overall comparison between the levels of re-use, recovery and recycling achieved under the Directives. Several stakeholders also pointed out the need to have a clear list of applications that are allowed as recycling or recovery operations for all waste stream Directives.

Other types of targets

Some stakeholders would support the introduction of a distinction between closed loop recycling and down-cycling, with associated quantitative targets. Closed loop recycling would be given a higher priority since it enables the reuse of resources over and over again, with environmental benefits higher than in the case of down-cycling.

Stakeholders were relatively sceptical as to whether current targets based on weight should be complemented by targets based on actual environmental impacts. Issues concerning data reliability were raised in particular (knowing that there is already significant uncertainty on reported figures based on weight). GHG emissions could be a possible useful indicator for future targets. Other examples of indicators which could be used in future targets are those proposed by the Global Packaging Project, a range of 52 indicators which cover environmental (including life-cycle), economic and social indicators, and include measures such as packaging weight, total material input, packaging to product weight ratio, transport packaging cube efficiency, packaged product wastage, packaging service value, product safety, packaged product shelf life, etc. [47]

2.2.5 Extended producer responsibility

Extended Producer responsibility (EPR) is implemented in ELV, WEEE and Batteries Directives with an objective of improving the end-of-life management of products. However, the potential benefits expected from the implementation of EPR are currently limited by a number of factors such as:

[47] The consumer goods forum, 2010, A global language for packaging and sustainability (http://globalpackaging.mycgforum.com/allfiles/GPP_FinalReport_v1110.pdf)

- EPR schemes have many different configurations across the Directives and across the MS, in particular in terms of level of detail of the scheme and terminology (producer, economic operator, market, etc.). The questions of who must pay, what are the associated costs and the proportion of costs for which producers are liable are applied differently in the MS. These variations create uncertainty for companies operating in different MS and additional administrative burden. Table 6 below illustrates the differences between Directives' EPR schemes via a comparison between the ELV producer responsibility scheme and the one set up in the current version of the WEEE Directive.

Table 6 : Comparison between ELV and WEEE Directives' EPR schemes

ELV Directive	WEEE Directive
Articles on Producer Responsibility are relatively simple requiring that: • ELV are delivered to treatment facility without costs to the last holder • MS take the necessary measures to ensure that producers meet all or a significant part of the costs of implementation or they take back ELV.	Between the development of the ELV Directive and adoption of the WEEE Directive, EPR requirements became much more specific. In the WEEE Directive: • Distributors supplying a new product must ensure that waste can be returned to them free of charge • For WEEE from private households, MS must ensure that each producer is responsible for financing the collection, treatment, recovery and environmentally sound disposal of waste from their own EEE products (individually or via collective schemes) • Producers should provide a guarantee when placing a product on the market, showing that the management of all WEEE will be financed • The collection, treatment, recovery and environmentally sound disposal of WEEE from users other than private householders can be borne by producers or by users, partly or totally.

- There is a lack of clarity on how to apply EPR requirements for products subject to two different waste stream Directives, e.g. for batteries contained in WEEE or contained in ELVs. For example, the level of producer responsibility in the Batteries Directive is defined at the MS level, while in the WEEE Directive it is defined at EU level; there is also a double charging of producers that place a battery in the EEE before sale.
- The WFD contains non-binding provisions on EPR. However, these provisions are broad and flexible and therefore do not provide a clear and consistent basis for implementation across MS.

It would be very beneficial to have a unique and common conception of the following terms: "producer responsibility", "producer", "placing on the market" in order to provide a clear baseline for applying the "polluter-pays-principle" to producers of products and ensuring waste is adequately considered in design and the operations of producers. The Commission's "Guide to the implementation of Directives based on the New Approach and the Global Approach" could be a model for clarifying definitions for such concepts. Such an effort would obviously need to

take into account potential implementation and enforcement difficulties and differences between MS if too strict of a definition is put into place.

There is a need for consistency in approach across the EU market place in order to reduce uncertainty for the industry sector.

2.2.6 Quality of collection schemes and quality of recyclates

Requirements related to quality are of primary importance to ensure high material quality during the entire waste management chain, facilitate recycling and material recovery and therefore contribute to resource efficiency.

Ensuring good quality of separate collection at post-consumer stage

Better quality in the separate collection of recyclable material would result in higher proportions of waste accepted for recycling or material recovery, and therefore lower proportions sent to energy recovery or disposal that are at lower levels in the waste hierarchy than prevention and recycling. Increased efforts at the MS level to improve waste separation will enable high quality recycling. Possible actions include awareness raising campaigns, communication, waste separation controls, and economic instruments. EU legislation could introduce provisions requiring that MS make additional effort to improve separate collection. This requirement has been introduced in the WFD in broad terms: "waste shall be collected separately if technically, environmentally and economically practicable".

It should be noted that in some MS financial incentives are in place to develop waste sorting infrastructure, which may be in contradiction with the objective of a high quality of separate collection at the post-consumer stage.

Ensuring waste quality at the interface between the collector and the recycler

Taking plastics as an example, the economics of plastic recycling is heavily dependent on the quality of plastic waste. Poorly sorted and highly contaminated waste material will impact on the ability to recycle the material. National specifications can be put in place to ensure a high level material quality. For instance, recyclers/reprocessors in France can use a codification set up by FEDEREC (Federation of recyclers) in order to clearly express their needs and quality requirements. This national codification classifies waste plastic materials by material type and quality. The future implementation of end-of-waste criteria for plastic materials should also contribute to better quality of plastics intended for recycling[48].

Ensuring good quality of recyclates

Good quality of recyclates is necessary to ensure the effective functioning of markets for secondary raw materials. Some standards are already in place but depend on the material, the

[48] JRC,2010, Study on the selection of waste streams for end-of-life assessment (http://ftp.jrc.es/EURdoc/JRC58206.pdf)

country and often on the provisions of the contract made between the waste trader and the recycler. However, the future implementation of the end-of-waste criteria for certain waste streams shall put in place quality standards adapted to each type of material to allow waste to shed its waste status. These standards should help promote a minimum and harmonised level of quality. Criteria for iron and steel scrap[49], aluminium and aluminium alloy scrap[50], copper and copper scrap[51], paper[52], and glass have been developed recently. Technical proposals are still under development for biodegradable waste and waste plastics.

2.2.7 Other drivers

Economic instruments

Economic instruments could be considered as drivers, whose potential in terms of improved waste management is not fully exploited yet. Such instruments are already used in many MS but with varying levels of requirements and performance, therefore the benefits of these schemes could be explored, even though most of them cannot be developed at the EU-level but only at the MS level. An adequate use of economic instruments on the top of EU legal instruments could lead to better performances. In addition to the EPR principle, which is already included in the waste stream Directives, economic instruments that could be used include for example:

- **Pay-as–you-throw (PAYT) schemes**: They are used in several MS as a fiscal incentive to encourage consumers to improve waste separation and/or reduce wastage. However, precaution against illegal waste dumping or misuse of recycling facilities should be taken. Full financing of the waste-management infrastructure has to be assured and sufficient awareness-raising is necessary. PAYT generally has a positive impact on recycling.
- **Deposit refund schemes**: They are used in some countries and have proved to have a positive effect on recycling; they are used either as self standing tools or as complementary tools. For instance, in Sweden recycling rates for all metal packaging were around 65% in 2004-2005, but the recycling rate for aluminium under the deposit-refund scheme was 85% to 86% in the years 2002 to 2007, while the return rate for glass bottles is 99% on 33cl bottles and 90% on 50cl bottles. Similarly, in Germany, recycling rates in 2005 were 50%, 85%, 76% and 79% for plastics, tinplate, aluminium and glass respectively; while the reported return rates under the deposit scheme are 95-99%. [53]
- **Grants schemes**: They are used for instance to promote separate collection or reuse.
- **Landfill taxes applied to landfill gate fees**: Volumetric landfill taxes can encourage the reduction of waste and the use of secondary materials over primary materials. They are

[49] JRC IPTS, 2010, End-of-waste Criteria for Iron and Steel Scrap: Technical Proposals: (http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=3479)
[50] JRC IPTS, 2010, End-of-waste Criteria for Aluminium and Aluminium Alloy Scrap: Technical Proposals (http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=3480)
[51] JRC IPTS, 2011, End-of-waste Criteria for Copper and Copper Alloy Scrap: Technical Proposals (http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=4259)
[52] JRC IPTS, 2011, End-of-waste criteria for waste paper: Technical Proposals (http://ipts.jrc.ec.europa.eu/publications/pub.cfm?id=4139)
[53] Eunomia, 2010, Have we got the bottle? Implementing a deposit-refund scheme in the UK

relatively easy to implement but their effectiveness depends on the tax rate per tonne of waste and on the existence of adequate monitoring and enforcement measures. It is also important to ensure that the tax does not result in increased illegal dumping rather than encouraging recycling[54]. This tool is used by a large majority of MS to encourage the diversion of waste from landfill, but with significant differences in the level of taxes.

- **Taxes on single-use items** generating high quantities of domestic waste (e.g. tax on plastic bags, disposable cutlery, plastic film and aluminium foil implemented in Belgium in 2007).

The use of economic instruments and their potential effect on waste management performances is currently being investigated as part of a study for DG ENV[55].

Other possible drivers

The implementation of landfill bans for additional categories of waste could be another driver. Landfill bans already exist in the Landfill Directive for types of waste such as tyres or hospital waste. Some MS have extended the scope of these bans to cover plastic bags, for example, with successful results in terms of improved recovery rate (see Box 3 below).

Another possible type of driver is a ban on single-use products which generate high quantities of waste. Some MS have introduced such measures; for example, Italy has recently (January 2011) banned the use of non biodegradable plastic carrier bags; however this measure may be in contradiction with the Packaging Directive. In any case, when considering the possible implementation of such product bans at EU level, the proportionality of such measures would need to be proven. In the case of plastic carrier bags, the Commission is currently investigating options to reduce the use of plastic carrier bags and has launched a public consultation and a study on this subject[56].

Additional instruments such as green certificates for recycled products aimed at recognising the benefits associated with recycling may also be a driver for improved recycling, although this is a relatively complex system.

[54] UNEP, 2011, Towards a green economy – Pathways to sustainable development and poverty eradication (http://www.unep.org/greeneconomy/GreenEconomyReport/tabid/29846/Default.aspx)

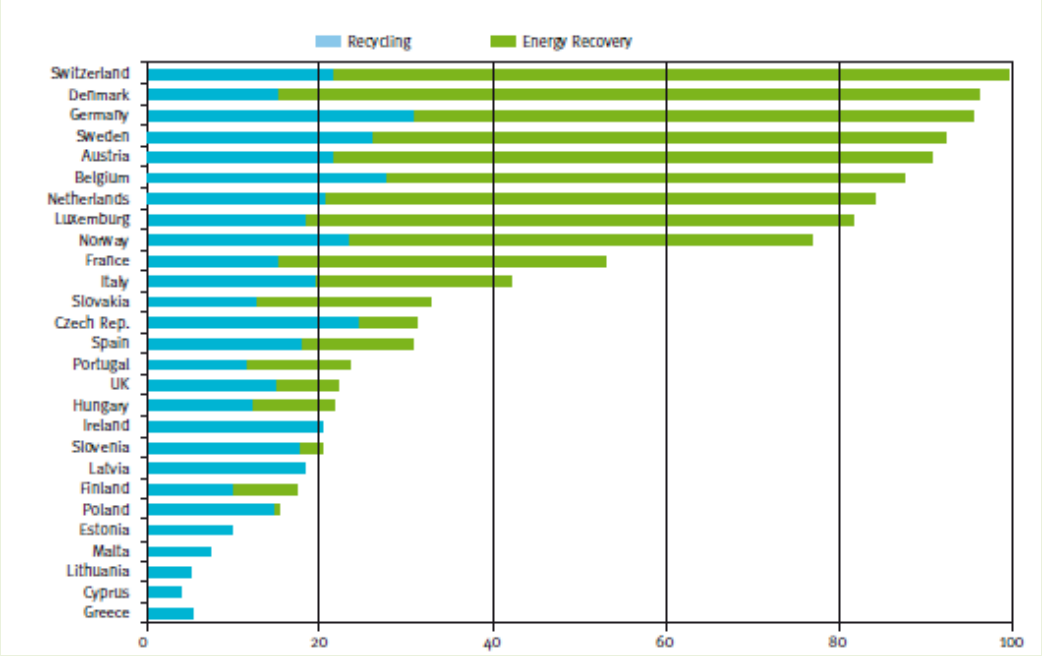
[55] IEEP, BIO Intelligence Service, et al., Use of economic instruments and waste management performances, Ongoing study for DG ENV (http://ei-waste.eu-smr.eu/)

[56] Press release, May 2011: http://europa.eu/rapid/pressReleasesAction.do?reference=IP/11/580&format=HTML&aged=0&language=EN&guiLanguage=en

Box 3: Plastic recovery performances and landfill bans

The figure below shows the discrepancies between EU countries in terms of plastics' treatment.

Figure 8: Post-consumer plastic waste: recycling and recovery rates per country[57]



In Switzerland, Germany, Sweden and Denmark there is almost no landfilling – these countries are very close to completing their diversion-from-landfill strategy. Also Belgium, Austria, Luxembourg and the Netherlands recover more than 80% of their post-consumer plastic waste. On the other hand several of the new MS but also the UK, Ireland and Greece, only recover around 20%.

It is striking to note that countries achieving the highest plastic recycling and recovery rates i.e. Switzerland, Denmark, Germany, Sweden, Austria, Belgium, Netherlands, Luxemburg, Norway are those which have put in place a landfill ban, absolute or not, covering plastics[58].

2.3 Analysis of recycling targets

This section aims to assess the adequacy of quantitative waste management targets currently included in the waste stream Directives, and in particular their coherence with the overall aims of EU's waste policy i.e. achieving resource efficiency and moving towards a "recycling society". To address this question, a preliminary analysis of the desirability and the practical feasibility of setting more stringent targets in those Directives was conducted. The targets analysed are those defined for batteries, ELVs, WEEE and packaging waste, as presented in Table 1.

2.3.1 Current level of achievement of targets

An analysis was undertaken of the quality and extent of current reporting on the implementation of the Directives, the current level of achievement of the various recycling targets, and the associated environmental benefits. The details of this analysis are presented in Annex 2, which is

[57] Plastics Europe, 2008, The compelling facts about plastics
[58] F. Huysman EPRO chairman, 2009, Plastic Waste Management in Europe

mainly based on the review of impact assessment and implementation studies for the various waste stream related Directives.

This overall assessment shows that, while the targets defined in the Packaging Directive have been met by a majority of MS, significant issues have been identified with regard to compliance with the recycling targets set by the ELV Directives; compliance with the WEEE Directive appears to be improving. For the Batteries Directive, only limited information is yet available since the first official reporting to the EC is required as of 2013; in 2008, the average collection rate was estimated at 18% and 7 MS had already met the 25% target (compliance deadline is 2012).

In terms of environmental benefits, it is estimated that significant environmental benefits have been achieved through the implementation of the Packaging Directive. The ELV Directive has resulted in moderate environmental benefits to date; it has contributed to promoting resource efficiency via innovation in vehicle design and treatment of ELVs and to improving efficiency of the treatment sector (recyclability). With regard to the WEEE Directive, collection appears to be improving and is up from 1/3 to over 2/3 of EEE placed on the market, according to data reported in 2008[59].

2.3.2 Material savings from recycling with all current targets fully reached

Potential environmental benefits resulting from the full achievement of collection and reuse-recycling-recovery targets are analysed qualitatively in Annex 2. Overall, it is estimated that relatively high environmental benefits could be achieved if ELV recycling targets were fully met; in particular, this would require the improvement of recycling and recovery of plastics from shredder residue. For the Packaging Directive, minimal change with regard to the current situation is expected. The new version of the WEEE Directive (currently under recast) will most likely include more stringent targets and significant environmental benefits are expected from these new requirements. For the Batteries Directive, limited information is yet available on the current implementations status, but significant material savings can be expected from the full achievement of the 2016 collection target and currently applicable recycling targets.

It is assumed that the currently recycled amounts of materials represent approximately 67% of the total amounts which could be recycled if all targets set in EU legislation were fully reached[60], which means there is room for improvement.

2.3.3 The potential for stricter targets

Following this analysis, the desirability and feasibility of more stringent targets was assessed in relation to the percentages of waste collected and recovered and the deadlines for compliance. The details of this analysis are presented in Annex 3 and is summarised as follows:

[59] Eurostat, 2008, WEEE collection rate, kg per capita
http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/data/wastestreams/weee

[60] BIO Intelligence Service et al., 2011, Analysis of the key contributions to resource efficiency, for DG ENV (http://eu-smr.eu/reseff)

Batteries Directive

It is difficult to assess the practical feasibility of implementing stricter targets for battery recycling, as limited data currently exists on target achievement and potential for improvement (the first set of implementation reporting on the recycling targets is due in 2013). However, a recent study[60] estimated that a collection target of 80% would be feasible in the long term, based on current best practices identified in MS and technical capabilities; the same study considers that recycling efficiencies for Ni-Cd and lead-acid batteries appear to be close to their potential value at present, while for other battery types increasing the recycling efficiency target from 50% (current level) to about 70% would seem feasible in the long term[61]. Nevertheless, a stakeholder considered this higher objective as unrealistic[62].Further research is therefore needed to assess the practical feasibility of implementing stricter targets.

Packaging Directive

Increasing quantities of packaging, including glass, metals, paper and cardboard, plastics, and wood are placed on the market and increasing recycling is considered one of the most cost-efficient methods of reducing the environmental impacts linked to packaging waste. The highest achieving MS recover 80-90% of all packaging and recycle 70-80%, which appears to represent a plateau in performance[63]. The implementation of more stringent recycling targets does not seem very feasible at EU level in the short term (e.g. next 5 years): MS are currently struggling to maintain or further increase the recycling rates. Markets dynamics across the EU-27 are also important in packaging waste, meaning that allowing newer MS to comply with the current targets is very important before increasing targets further.

It should be noted that, unlike other waste streams Directives, the Packaging Directive provides a maximum recycling target of 80%. This is based on the consideration that incineration with energy recovery may be better than recycling in some cases, for environmental and economic reasons; however, such a maximum threshold may be adjusted in the future. In fact, the optimum recycling target per packaging material depends on the number of parameters including the collection method of household packaging waste, the alternative waste treatment method and the amounts of household and industrial packaging waste; therefore, the optimal recycling rates achievable may be different for each MS[64].

End-of-Life Vehicles Directive

Existing targets for 2015 are already a stretch and are expected to stimulate eco-innovation and provide economic and environmental benefits. The costs of extending rates much beyond current levels rise extremely steeply because of the increasing labour input per kilogram treated.

[61] It should be noted that numerous factors can influence battery collection including population density, infrastructure, consumer awareness, and geography.
[62] Private communication with the European Portable Battery Association
[63] Eurostat, 2008, Recycling rates for packaging waste http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/data/wastestreams/packaging_waste
[64] RDC & Pira, 2003, Evaluation of costs and benefits for the achievement of re-use and recycling targets for the different packaging materials in the frame of the Packaging and Packaging Waste Directive 94/62/EC, for DG ENV

WEEE Directive

The WEEE Directive is currently undergoing a recast, and as outlined in the EC's Communication on the WEEE recast published in 2008, the WEEE recast seeks to address the following problems related to the application of the WEEE Directive: [65]

Table 7 : Problems related to the WEEE Directive and solutions brought by the recast

Issues identified	Solutions brought by the recast
• Lack of clarity on the products covered and their categorisation • Separate collection of approximately 65% of EEE placed on the market but treatment in accordance with the Directive of less than half this amount • Lack of targets on the re-use of whole appliances • Lack of detailed enforcement requirements • Divergence of producer registration requirements across MS • Indications of illegal export and substandard treatment of WEEE[66].	• Revision of product categories covered by the Directive • Clarification of the scope and definitions used in the WEEE Directive, detailed definition of producer • Replacing the 4 kg/inhabitant collection target by a 45% WEEE collection rate for the first 4 years of entry into force of the recast Directive, and by a 65% WEEE collection rate for the second 4 years of entry into force of the recast Directive. • Recovery and re-use/recycling targets further refined • Harmonisation of registration and reporting obligations • Introduction of specific guidance on inspections for used EEE suspected to be WEEE

Therefore current issues with the WEEE Directive appear to be largely addressed by the modifications to be undertaken in the recast version of the Directive and further increases in collection and recycling targets are already underway.

Quantitative modelling

The above findings can be complemented by quantitative modelling results from a recent study for DG ENV on key contributions to resource efficiency[18], which provides rough estimates of the amounts of waste materials which 1) are currently recycled, 2) would be recycled if all existing collection and reuse-recycling-recovery targets were fully met and 3) would be recycled in a best practice scenario. The estimates developed in this study are summarised in Figure 9 and Figure 10 below. It should be noted that these estimates do not fully take into account the economic

[65] EC, 2011, Proposal for a Directive of the European Parliament and of the Council on WEEE – (recast) – Political agreement (http://register.consilium.europa.eu/pdf/en/11/st07/st07851.en11.pdf)

[66] EC, 2008, Proposal for a revised directive on waste electrical and electronic equipment (http://eur-lex.europa.eu/LexUriServ/LexUriServ.do?uri=CELEX:52008PC0810:EN:NOT)

feasibility of imposing higher recycling targets, in particular the cost-effectiveness aspects. Best practice scenarios are usually based on reuse/recycling levels achieved in best performing MS.

According to these figures, the WEEE waste stream would show the highest potential for improvement in a best practice scenario, mainly because of a possible higher collection rate (as in the recast proposal) and considering already achieved reuse/recycling rates.

Figure 9: Estimates of amounts of waste materials corresponding to actual collection and recycling practices, achievement of targets and best practice – ELVs, battery waste and WEEE[67]

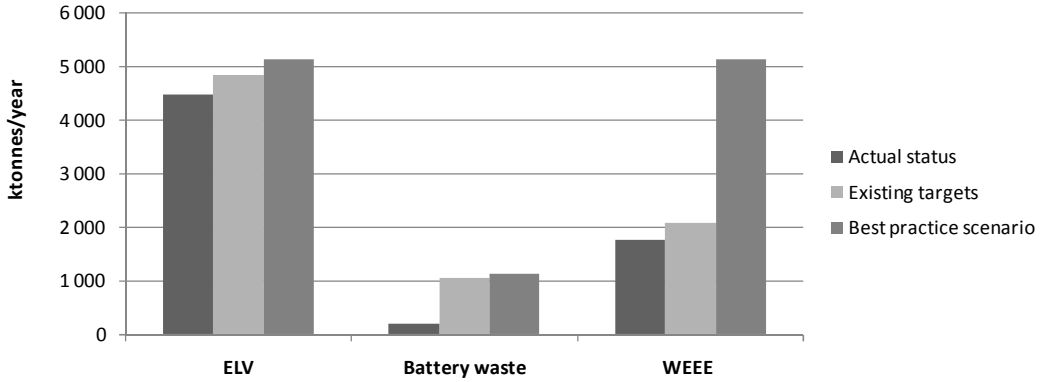
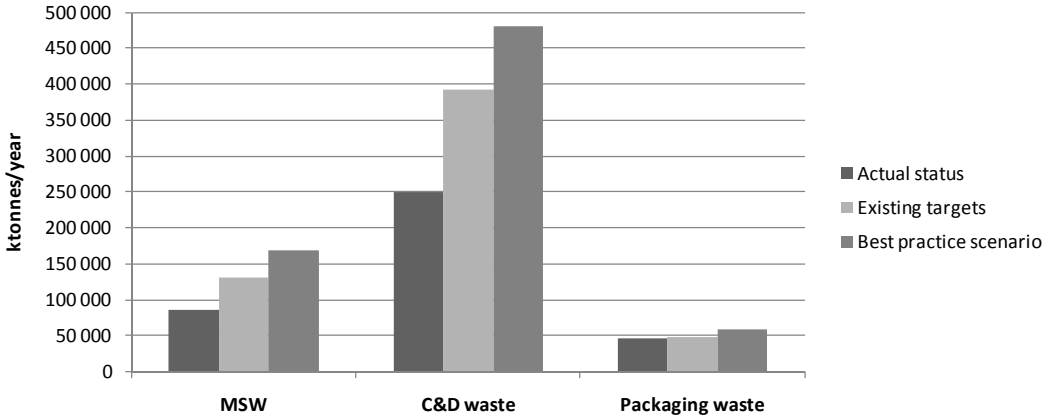


Figure 10: Estimates of amounts of waste materials corresponding to actual collection and recycling practices, achievement of targets and best practice – MSW, C&D waste and packaging waste[67]



Notes:
All amounts are to be interpreted with caution since most of them are rough estimates.
Actual status (collection and recycling): Estimates based on EU waste statistics and other sources, including some gap filling when data was not available
Existing targets: Taking into account all existing collection and reuse-recycling-recovery targets (applicable now and in the future) as presented in Section 2.1.3. For WEEE, the targets are those for 2006 (not the recast proposal)
Best practice scenario: Based on levels achieved in the few best performing MS for each waste category and an assessment of technical potential for improvement. The assumptions made can be summarised as follows:
- ELV: 90% reuse/recycling
- WEEE: 65% collection rate; reuse/recycling rates as currently observed (55% to 95% depending on the EEE – since in most cases these rates exceed the values of the recast proposal)

[67] Data from EU based waste statistics and other sources, as presented in the report by BIO Intelligence Service et al., 2011, Analysis of the key contributions to resource efficiency, for DG ENV

- Battery waste: 80% collection rate for portable batteries; Ni-Cd and Pb-lead batteries: recycling efficiency similar to current targets: other batteries: 70% recycling efficiency
- MSW: 65% recycling level for all MS, except DE (66%, current level achieved)
- C&D waste: 90% reuse/recovery for most MS and the current reuse/recovery rates for MS already achieving > 90%
- Packaging waste: reuse/recycling at 77% for paper, 73% for wood, 43% for plastic, 69% for metals and 83% for glass (based on various assumptions).

In the case of the Packaging Directive, where recycling targets are defined by type of material, quantitative modelling results show some potential for improvement, especially in the case of wood and plastics, between the current situation and a best practice scenario based on best performing MS (see Table 8 below).

Table 8: Comparison between current packaging recycling targets and possible recycling rates in a best practice scenario[67]

Packaging waste material	Current targets	Recycling rates in a best practice scenario
Paper and board	60%	77%
Glass	60%	94%
Metals	50%	69%
Plastic	22.5%	43%
Wood	15%	73%
Total	**15-60%**	**73%**

2.3.4 Issues related to reporting

There are a number of definition and standardisation issues across reporting on the Directives and the EU canon of waste legislation. Firstly, there is a lack of definition of which categories of waste, as defined in the European List of Waste (LoW), are actually covered by which targets. Additionally, MS cite a number of problems resulting from the structure of the LoW and the classification procedure, notably:

- Problems concerning the classification of hazardous waste and the application of mirror entries
- Problems resulting from the lack of suitable waste codes
- Ambiguous classification on account of two or more possible codes
- Problems resulting from unclear or imprecise definitions[67]

There is a conflict between having a less extensive waste list and having specific entries for every waste type. Secondly, the targets in the waste streams are not comparable as they are based on different baselines and endpoints; a lack of standardisation in terms of scope definition also contributes to reporting issues.

C&D waste, for example, has not been subject to recycling and recovery targets in the past, hence no standardised reporting systems have been developed, meaning diverging methodologies are used and different wastes considered as falling into the C&D category.

Therefore, estimates of existing C&D waste generation range from 510 to 970 Mt/year; some MS have not reported any figures while others appear to include excavation material in their figures.[9]

Reporting on packaging waste is another problematic example: MS reporting on packaging waste face the challenge of trying to monitor against new targets in terms of materials, while existing data does not differentiate between materials. Furthermore, most MS do not have any rules or guidelines for companies to prove compliance with the Essential Requirements other than those standards set out by the European Committee for Standardisation (CEN).[68]

Another area for improvement in terms of reporting is the split by material type. A recent study for DG ENV[69] highlighted that due to the large variety of waste streams generated in industry, trade, services and waste treatment, the fractions of reported plastics, paper, metals and glass are rather limited compared to other streams; however, these fractions are often mixed in with mixed industrial waste or reported as part of other waste streams, which are only split off by materials at a later stage. For example, as the use of plastics spans across a broad range of industries and products, and the variety of plastics materials which can be used is quite diverse, reporting on plastics waste quantities may underestimate actual quantities put on the market. It is not only difficult to capture plastic waste quantities, but also the wide variety of polymers can be a barrier to recycling. For example, plastics recycling is lowest in ELVs, due largely to the wide variety of polymers used; marking components at production or improving sorting technologies will be important to facilitating accurate reporting and fulfilling ELV recycling targets.[70]

Reporting obligations do not exist for the RoHS Directive (2002/95/EC) and reporting on the Batteries Directive (2006/66/EC) is not due until 2013. Reporting for the Packaging Directive (94/62/EC), the End-of-Life Vehicles Directive (2000/53/EC) and the WEEE Directive (2002/96/EC) remain problematic. Quality of reporting varies, with many replies incomplete and a lack of timeliness in submission of reporting. Currently one infringement case for failure to report in the WEEE Directive is pending, and six cases are still pending for the End-of-Life Vehicles Directive.

2.4 Comparison with a material-based approach

Current EU waste policy includes mandatory waste management provisions for specific end-of-life products, e.g. packaging waste, WEEE, ELV and batteries. As presented in Section 2.1, several types of materials are contained in products subject to several waste stream Directives; this is the case of plastics for example, which is contained in four categories of end-of-life products covered by the waste stream Directives and in two additional categories of waste streams specifically covered by the WFD (MSW and C&D waste). On the other hand, certain waste materials of potential concern are not covered (or only partially covered) by quantitative waste management objectives (e.g. bio-waste). This raises the question of whether policies imposing quantitative waste management targets and other specific requirements are more efficient if they are product- or material-based, or both.

[68] Arcadis, 2009, A survey on compliance with the Essential Requirements in the Member States, for DG ENV
[69] Arcadis, BIO Intelligence Service, VITO, and Umweltbundesamt, 2010, Analysis of the evolution of waste reduction and the scope of waste prevention, for DG ENV (http://eu-smr.eu/wasterp/)
[70] BIO Intelligence Service et al., 2010, Plastic waste in the environment, for DG ENV (http://ec.europa.eu/environment/waste/studies/pdf/plastics.pdf)

It was analysed whether the current approach to cover specific waste streams with separate legal instruments is appropriate, or whether legislation focusing on recyclable materials would be more likely to produce better results and would be more coherent with the overall goals of EU's waste policy.

To answer this question, two possible policy options were identified and briefly analysed, as follows:

- **Option 1**: Complement to the waste stream Directives, with specific waste management objectives and quantitative targets for re-use/preparation for re-use/recovery by material type, for example, in the WFD
- **Option 2**: Replace current waste stream related Directives by a new policy instrument with quantitative targets for the main types of waste materials.

2.4.1 Analysis of Option 1: Complementary approach

This option assumes that, in addition to the current waste stream related Directives, quantitative targets for re-use/preparation for re-use/recovery by material would be included in the specific Directives or in the WFD (as it already exists for materials from municipal waste).

Material-related targets would be applicable to the overall waste quantities at MS level. Materials of highest environmental concern and strategic importance would have to be identified, so that relevant targets could be set for these materials. MS would be free to decide which waste streams should be targeted in priority to reach the overall material-related targets, taking into account for example the key sources of waste production at national level and the cost-effectiveness of preventing and recycling/recovering the material of concern in different types of waste streams.

In the case of packaging waste, material-based targets are already present in the Packaging Directive (in addition to overall targets based on quantities of packaging waste). In some MS, material-based targets have also been implemented for additional waste streams (e.g. in Flanders, material-based targets for the recycling of plastics, metals, etc. set for WEEE). Option 1 would involve adding another higher level of targets at MS level (all types of products considered), which would need to be consistent with existing material-based targets for specific waste streams.

In parallel, waste stream Directives would need to be improved to ensure better linking with the WFD; for example to ensure a reconciliation of the different legal bases of certain waste stream Directives, such as the Packaging Directive, with the WFD. New Directives could still be developed if new waste streams of concern were identified.

Such a policy option has already been mentioned by previous studies and for certain waste streams; for example, a 2010 report on ELVs by the European Parliament concludes that "in order to achieve an environmentally sound treatment of end-of-life vehicles it would be useful, in

addition to the overall recycling and recovery targets, to establish specific treatment obligations for particular material streams, taking into account their overall environmental impact"[71].

The likely benefits associated with Option 1, compared with the current situation, would include the following:

- **Wider coverage**: Most waste streams would potentially be covered by specific waste management objectives, including quantitative objectives, compared to the current approach where specific quantitative targets cover only a limited proportion of total waste volumes. Indeed, it can be roughly estimated that, if all current recycling targets were met, approximately 580 Mt/year of materials would be recycled, representing only around 20% of total EU waste production; if only considering plastic waste, approximately 37% of EU plastic waste would be recycled if targets from the waste stream Directives and the WFD were met[72] (please refer to Section 2.1 on page 19 for further details). This policy option would be particularly relevant in the case of new products made of known materials; however, it would not be effective in the case of new products made of novel materials.
- **Precautionary principle/safety net**: Possible environmental impacts associated with the end-of-life of any new products placed on the market could be better prevented and managed, rather than having to be dealt with once they have actually occurred and already caused environmental damages. This would also enable to cover waste streams that have escaped notice for several years but could become problematic if they grow significantly, or obsolete products that holders tend to store for a long time before discarding them and could represent significant waste volumes (e.g. old video/audiotapes).
- **Links between waste management and resource use, better coherence with resource efficiency policy**. The development of a resource efficiency policy requires improved knowledge on the flows of materials in the economy, including the amounts of secondary materials from recycling activities that could re-enter the production processes and would therefore contribute to resource savings. Having material-based recycling/recovery targets in place would allow to estimate the likely amounts of secondary raw materials resulting from re-use and recycling activities. This would also encourage MS and the various players involved to develop more accurate estimates of materials flows. Having more accurate estimate would then facilitate the management of waste materials. For example, applying such an approach to plastic waste may improve the reliability of data for non-packaging waste volumes (at present it is very difficult to obtain reliable data outside of the regulated packaging waste stream).
- **Functioning of markets for recyclates**: Such an approach could provide more certainty on future flows of recyclates to be produced, for the materials covered by the targets. This could increase the attractiveness of recycling activities. If material-based targets are ambitious enough and cover a wide range of materials, this would result in higher

[71] European Parliament, 2010, End of life vehicles: Legal aspects, national practices and recommendations for future successful approach

[72] Potentially recycled amounts estimated based on the study BIO Intelligence Service et al., 2011, Key Contributions to Resource Efficiency, for DG ENV

requirements for recycling and material recovery activities and would promote further development of such activities.

- **Maintaining the Extended Producer Responsibility schemes currently in place in MS:** Within this option, EPR schemes could remain unchanged; however, some adjustments would have to be done by MS to take into account the material content of products covered by the EPR schemes. Such an approach is already taken by the Packaging Directive that sets different targets depending on the material type (metal, glass, paper, etc.).

Option 1 would probably incur significant costs to public authorities and enterprises in the short term in order to implement and enforce the quantitative targets at MS level; efforts for data collection and monitoring results could be high. In the case of limited demand for certain secondary materials, due to increased quantities of such secondary raw materials placed on the market, this could result in financial difficulties for recyclers. Furthermore, it may be difficult to further increase recycling rates for highly demanded materials such as metals. However, initial high costs may be compensated in the longer term, once the new approach is in place and provides a clear and consistent framework contributing a reduction in administrative burden. Calculations of costs and benefits associated with Option 1 would deserve further investigation.

2.4.2 Analysis of Option 2: New material-based policy

Option 2 is a quite radical option since it assumes that the current waste stream related Directives would be replaced by a new policy instrument containing quantitative targets on re-use/preparation for re-use-recovery for the main types of waste materials that can be recycled (paper, plastic, metal, etc.). Such an approach could be justified by the fact that continuing to develop separate legal instruments for new streams of end-of-life products in the future could create considerable administrative burden and potential additional inconsistency issues compared to the environmental benefits obtained, especially if the concerned waste streams are smaller in volume or have less environmental impacts than the ones already covered.

In the 2005 EU Thematic Strategy on Waste Prevention and Recycling[73], it was indeed stated that "Recycling directives adopted over the last decade are facilitating the setting-up and financing of recycling infrastructure for large waste streams; however it is difficult to justify application of this approach to a new range of waste streams".

Switching to a material-based approach could bring a number of benefits similar to those associated with Option 1. In addition, this would avoid the administrative burden associated with the potential implementation of new waste stream Directives for specific new types of products in the future (products are changing more quickly than materials). Nevertheless, this option presents major drawbacks in terms of administrative burden, since considerable administrative burden would be expected to implement the new policy framework, at least in the short term.

In addition, applying the EPR principle in a material-based approach would be more complex than in the case of end-of-life products. In its article dealing with EPR, the WFD targets "any

[73] Communication from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the regions, COM,2005, 666 Final, Taking sustainable use of resources forward: A thematic strategy on the prevention and recycling of waste

natural or legal person who professionally develops, manufactures, processes, treats, sells or imports products (producer of the product)". It seems difficult to put in place a scheme that would put the responsibility burden on material producers, since most of the waste actually generated consists of products rather than materials. For instance, it would pose practical problems as regards the acceptance of returned "materials" rather than products. In addition, the article of the WFD stating that 'In accordance with the polluter-pays principle, the costs of waste management shall be borne by the original waste producer or by the current or previous waste holders' seems hardly applicable to material producers.

Besides, all the national recycling organisations currently in charge of the regulated waste streams would have to be replaced by organisations dedicated to *material* recycling which would create significant administrative burden and might undermine the management of currently regulated waste streams, at least in the short term.

2.4.3 Conclusions

At present time, it seems that the waste stream related approach and the material-related approach should be seen as complementary approaches rather than mutually exclusive approaches.

For waste products with complex design and supply chain (e.g. WEEE), having specific separate legal instruments seems to be relevant as this allows taking into account a high number of technical parameters and ecodesign criteria. However, for other waste streams such as bio-waste, the adequacy of a separate legal instrument is more arguable; having such waste streams covered by material-based targets included in the WFD may be more relevant.

The introduction of material-based targets, in addition to specific waste stream related provisions, could bring significant environmental benefits in the short term. Cancelling the current waste stream Directives and focusing only on recyclable materials does not seem to be a realistic option in the short term, due to the considerable administrative burden that would be incurred by modifying the legal framework.

Chapter 3: Environmental and socio-economic effects of the waste stream Directives

In brief: Waste streams Directives appear to have provided significant benefits from an environmental point of view, in particular with regard to resource efficiency, greenhouse gases emission reductions, energy savings and reduction in the release of hazardous substances. Nevertheless, higher benefits could be achieved by increasing collection and recycling and continuing efforts to divert waste from landfilling and incineration. With regard to economic aspects, the waste stream Directives seem to have had a positive effect on the EU internal market and the implementation of the producer responsibility principle has generally resulted in cost savings for public authorities, although limited ex-post analysis data exists. On the other hand, their implementation has resulted in substantial operating costs and administrative burden to companies, except in the case of the ELV Directive because of the higher monetary value of ELVs compared to other waste streams. Social effects of the Directives appear to be positive in terms of public health, occupational health, and jobs in the recycling industry in particular. Harmonising the five waste stream Directives and the WFD would likely provide additional environmental benefits while reducing implementation costs for companies and MS.

This chapter provides an overview of key environmental and socio-economic effects of the five waste-stream Directives targeted by this study. It includes a synthesis of environmental and socio-economic effects described in existing literature, in particular ex-ante and ex-post impact assessment studies conducted by the EC and/or by some MS as part of the implementation or review of the Directives. It also takes into account information provided during the stakeholder consultation. The information has been analysed in order to assess whether the implementation of the Directives has resulted in overall benefits at reasonable costs and to identify areas where the cost/benefit ratio could be improved. In particular, the influence of improved coherence in waste legislation on the cost/benefit ratio has been analysed.

3.1 Environmental effects

An overview of environmental effects resulting from the waste stream Directives is provided in Table 9 below. They are classified under three main categories: resource efficiency; greenhouse gases emissions and energy use; and release of hazardous substances.

Table 9: Key environmental effects of the waste stream Directives

Legend: + positive effect; - negative effect; ? uncertain effect; ≈ no significant effect

Resource efficiency		
Packaging Directive 94/62/EC	+	Increase of packaging recovery and incineration with overall recovery rate at 67% in 2008 (recycling + incineration with energy recovery)[74]. Increase of packaging recycling from 47% in the EU-15 in 1998 to 61% in the EU-27 in 2008.[75]
ELV Directive 2000/53/EC	+	20 MS achieved the reuse/recycling target of 80% in terms of average ELV weight; 16 MS met the 85% reuse/recovery target (but there might be over-estimates)[76]. However, evidence suggests that there is still room for improvement regarding the recycling and recovery of ELV materials.[77] A slow but real progressive replacement of illegal treatment facilities by authorised (and thus controlled) ones: about 50% of ELV are estimated being now treated in authorised treatment facilities in EU25.[78]
	–	A considerable number of ELVs are exported illegally from European MS; predominantly to Africa and the Middle Eastern countries. [77]
WEEE Directive 2002/96/EC	+	Since 2005, about 2 million t/year of WEEE in the EU have been diverted from disposal without any pre-treatment, by selective collection followed by treatment operations[79]. For each single category of WEEE, the future benefits of the WEEE Directive are very much related to increased collection and treatment of more appliances[80]. (NB: collection targets will be raised in the new version of the Directive)
RoHS Directive 2002/95/EC	+	Avoided waste quantities: of the initial amounts of hazardous substances present in EEE before the RoHS Directive's implementation, the following % have been diverted from disposal thanks to the implementation of the Directive: 20% of Hg, 56% of Cd, 59 % of Pb, 68 % of Octa-BDE and 71% of Cr(VI)[81]

[74] EC, 2006, Report from the Commission to the council and the European Parliament on the implementation of Directive 94/62/EC on Packaging and Packaging waste and its impact on the environment, as well as on the functioning of the internal market [SEC(2006) 1579]
[75] Eurostat, 2009, Recycling rates for packaging waste (http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/data/wastestreams/packaging_waste)
[76] According to Eurostat data from 2008
[77] European Parliament, 2010, End-of-life Vehicles: Legal aspects, national practices and recommendations for future successful approach
[78] GHK and BIO, 2006, A study to examine the benefits of the ELV Directive and the costs and benefits of a revision of the 2015 targets for recycling, re-use and recovery under the ELV Directive, for DG ENV
[79] EC, 2008, Commission Staff Working Paper accompanying the Proposal for a Directive of the European Parliament and of the Council on waste electrical and electronic equipment (WEEE) (recast) Impact Assessment {COM(2008) 810 final}
[80] UNU, 2008 Review of Directive 2002/96 on WEEE, Final report, for DG ENV
[81] Arcadis Ecolas, RPA, 2008, Study on RoHS and WEEE Directives, for DG ENV

Batteries Directive 2006/66/EC	+	The appropriate marking and labelling of batteries and accumulators is expected to aid the separate collection of portable batteries and accumulators at the end of their life, thus enabling their future treatment and recycling. In terms of industrial and automotive batteries, appropriate marking is expected to reinforce the prohibition on the disposal (via landfill or incineration) of these spent batteries as whole.[82]
Greenhouse gases and energy use		
Packaging Directive 94/62/EC	+	Up to 2004, all packaging recovery and recycling in the EU has saved roughly 10 million t of oil equivalent and 25 million t of CO_2 equivalent compared to a scenario where all packaging was landfilled or incinerated. Out of that, 1 million t of oil equivalent and 3 million t of CO_2 equivalent are the direct result of the implementation of the Packaging Directive.[83]
ELV Directive 2000/53/EC	+	Based on a scenario where the existing 2015 targets would drive technological progress to allow greater separation of plastics from shredder residue, the 2015 targets would bring about several environmental benefits, including estimated savings of between 280,000 and 980,000 t/year of CO_2 equivalent. The actual environmental benefit will depend on the technological development that the targets stimulate.[84]
WEEE Directive 2002/96/EC	+	Contributed to reduction of CO_2 through energy savings from recycled material (avoided carbon emissions for the production of new materials such as metals, plastics, etc.), although no supporting data is available with regard to those benefits.
RoHS Directive 2002/95/EC	≈	No significant effect
Batteries Directive 2006/66/EC	?	No information available

[82] UK Department for Business, Innovation and Skills, 2008, Impact Assessment of Implementation of Internal Market Provisions of Batteries and Accumulators Directive (2006/66/EC)
[83] Pira Ecolas, 2005, Study on the implementation of Directive on packaging and packaging waste and options to strengthen prevention and reuse of packaging, for DG ENV
[84] EC, 2007, Report from the Commission to the Council and the European Parliament on the targets contained in article 7(2)(b) of Directive 2000/53/EC on end-of-life vehicles {SEC(2007)14} {SEC(2007)15}

Release of hazardous substances		
Packaging Directive 94/62/EC	+	Avoided releases from restrictions in hazardous substances contained in packaging. However, most enforcement efforts are focussed on the heavy metals content of packaging. With regard to the heavy metal inspection, efforts can still be improved and increased. Some breaches have been observed; for example, in Belgium, results from inspection show a rather frequent violation of the requirement on hazardous substances, i.e. excess of heavy metal limits in packaging (art. 11 of the Packaging Directive). Even EU-made packaging from large brands often contains too high levels of heavy metals.[85] Reduced emissions of particulates, decreased acidification, less traffic noise, odour, visual disturbance, etc.[74]
ELV Directive 2000/53/EC	+	ELVs are treated illegally in some cases; however, the situation seems to be improving. This can also be seen from the fact that, compared to 2005, the numbers of authorised treatment facilities have increased significantly in some MS (UK, BE, GR) in recent years.[71] Expected reductions in photochemical oxidation, air acidification, water pollution and eutrophication and reductions in waste generated. The actual environmental benefit will depend on the technological development that the targets stimulate.[86] There are environmental benefits linked to: depollution (fluids, batteries, liquefied gas tanks, air bags); recycling of catalysts, tyres, glass, large plastic components, and metallic components. For instance, it can be assumed that without the ELV Directive, 10-15% of spent batteries would be improperly treated. Through the implementation of the Directive, 50% of them have already been captured; 2,000 to 4,000 t/year of sulphuric acid are not released into the environment anymore, avoiding the potential risk of contamination of water directly or from soil; 2,000 to 4,000 t/year of lead are diverted from waste. Life-cycle emissions of heavy metals have been reduced by nearly 100%; between 2000 and 2005 emissions related to hazardous substance use in vehicles was largely reduced and phasing out of lead, cadmium, mercury and hexavalent chromium is nearly completed.[87] However, even in authorised treatment facilities depollution is not in full compliance with the relevant requirements of the ELV Directive.[88]
WEEE Directive 2002/96/EC	+	Avoided releases from improved WEEE treatment (however, no detailed data on this aspect could be obtained)
RoHS Directive	+	Estimates of quantities of substances typically present in EEE whose use would be avoided due to RoHS in the EU: 130,600 tonnes/year of

[85] Arcadis, 2009, A Survey on compliance with the essential requirements in the Member States, for DG ENV
[86] EC, 2007, Report from the Commission to the Council and the European Parliament on the targets contained in article 7(2)(b) of Directive 2000/53/EC on end-of-life vehicles {SEC(2007)14} {SEC(2007)15}
[87] Öko-Institut, 2010, End-of-life vehicle directive 2000/53/EC Annex II: Study on analysis of costs and environmental benefits of heavy metal ban, and proposal for better regulation, for DG ENV
[88] European Parliament, 2010, End of life vehicles: Legal aspects, national practices and recommendations for future successful approach

2002/95/EC		lead, 6,250 tonnes/year of cadmium, 760 t/year of hexavalent chromium, 30 t/year of mercury and 18,470 t/year of Octa-BDE.[89] The impact of the RoHS Directive in terms of the relative amount of avoided human toxicity potential and ecotoxicity potential per RoHS substance as a share of the total amount before RoHS amounts to 100 % for Cr(VI) (assuming that all Cr(VI) would be avoided through the implementation of RoHS), 85% for Pb, 82% for Cd and 27 % for Hg.[89] Stimulation of compliance throughout the supply chain affecting also EEE outside the RoHS scope (knock on effect). Greater awareness about product composition and toxicity leading to better control of hazardous substances, including those not regulated by RoHS. Implementation of similar legislation worldwide and hence increase of the market pressure for reducing EEE toxicity, beyond the elimination of the regulated substances.[89]
Batteries Directive 2006/66/EC	**?**	No information available

3.2 Economic effects

An overview of economic effects associated with the waste stream Directives is provided in Table 10 below. They are classified under four main categories: EU internal market and competition; operating costs and administrative burden to companies (including SMEs); costs for public authorities; and R&D/innovation.

[89] Arcadis Ecolas and RPA, 2008, Study on RoHS and WEEE Directives, for DG ENV

Table 10: Key economic effects of the waste stream Directives

Legend: + positive effect; - negative effect; ? uncertain effect; ≈ no significant effect

EU internal market and competition		
Packaging Directive 94/62/EC	**+**	The Directive has provided safeguards for the free movement of packaging and packaged goods within the Internal Market. This results in lower costs and wider choice for the industry and for consumers (opinion expressed during stakeholder consultation).
	–	There is some legal uncertainty due to differences in scheme design between MS: ■ The producer responsibility systems put in place differ considerably in their design, and while all embrace the principle of producer responsibility, they vary in the extent to which direct costs are apportioned among the packaging chain, local authorities and other groups. They also vary in their comparative focus on household waste as opposed to industrial and commercial waste. ■ Past experience and ongoing cases show that unilateral measures adopted in different MS still pose problems by requiring market operators to adapt their packaging to the requirements of each individual MS[77]. Enforcement on the Essential Requirements is made difficult by the general and vague way in which the requirements are formulated and the way in which the CEN standards are set up. The authorities, on the other hand, show little interest in enforcing the Essential Requirements (although there are some examples of good practice in some MS). They leave it to the industry to comply[90].
ELV Directive 2000/53/EC	**+**	The Directive has provided a more certain environment in which the treatment sector can plan the development of capacity, which will be determined by recycling targets and will be less sensitive to market factors such as fluctuations in commodity prices.
WEEE Directive 2002/96/EC	**?**	The potential threat of competition distortion due to deliberately reporting of Business to Consumer WEEE as Business to Business WEEE, empty reporting without further action or simply not reporting is having unequal impact on those companies investing in realisation of full and EU-wide legal compliance.[80]
RoHS Directive 2002/95/EC	**–**	Achievement of the RoHS Directive's objectives is hindered and made more costly by problems related to uncertainties in implementation such as lack of harmonisation in interpretation of definitions and diverging requirements for demonstration of product compliance; problems with enforcement such as suboptimal market surveillance activities; and problems related to perceived inconsistency with other Community legislation or technical/scientific progress, such as potential overlaps with REACH or Ecodesign and need for extending the scope to cover medical devices and control and monitoring instruments.[91] First market surveillance activities have revealed a potentially high proportion of non-compliant EEE on the market (up to 44% in one MS) which increases the risk of future environmental harm.[91]

[90] Arcadis, 2009, A Survey on compliance with the Essential Requirements in the Member States, for DG ENV
[91] EC, Impact assessment of the recast, 2008 (SEC2008) 2930

Batteries Directive 2006/66/EC	**+**	UK example: UK implementation of the Internal Market provisions of the Batteries Directive is not expected to have a detrimental impact on competition in the market for batteries and accumulators. The ability for MS to withdraw new batteries and accumulators from their market that do not meet the requirements of the Batteries Directive, and the requirement for MS not to impede or restrict new batteries that meet the requirements of the new Directive, will have the benefit of protecting and promoting the European Internal Market in batteries. This should bring benefits in the form of greater competition in the market for batteries as a result of a more level-playing field for all manufacturers and producers of batteries. Both UK producers and consumers will benefit from this, in terms of potentially improved access to markets, and in terms of potentially higher quality, and safer types of batteries.[92]
Operating costs and administrative burden to companies (including SMEs)		
Packaging Directive 94/62/EC	**–**	The latest ex-post evaluation for the Commission suggests an attributable impact, in terms of cost and incremental recycling, that is comparatively modest in total but (i) increasing year-on-year (ii) unevenly distributed, with greater additional impact in those countries where packaging recycling systems were less well developed in the early 1990s. The annual net additional cost (financing need) of the additional recycling attributed to the Directive in 2001 in this evaluation was estimated at €227 million. The extent to which this cost is distributed across the packaging chain, municipalities and other actors varies among the MS. There are indicators of the impacts avoided (in terms of internal market effects arising from uncoordinated national measures), but these have not been quantified. The extent to which costs have been passed on to consumers remains undetermined.[90]
ELV Directive 2000/53/EC	**+/–**	Operating costs are lower than for other waste streams because there are natural economic drivers for recycling due to the high monetary value of the waste. The significant costs involved, and the requirement for all facilities storing and treating undepolluted ELVs to obtain a permit, have led to a significant rationalisation of the treatment sector as well as a significant increase in standards. The vehicle treatment sector is now widely regarded as being more efficient, professional and sustainable as a result of the Directive.[93] The ELV Directive can be regarded as a good example among the various waste stream Directives, having achieved high collection and recycling rates at reasonable implementation costs (opinions expressed during the stakeholder consultation). In addition to the ELV Directive's requirements, companies also have to comply with the Batteries Directive's requirements, which generates administrative burden for companies and some difficulties in understanding how to comply with both Directives (opinions expressed during the stakeholder consultation).
WEEE Directive	**–**	An administrative burden survey launched during the UNU study[80] highlighted that:

[92] UK Department for Business, Innovation and Skills, 2008, Impact Assessment of Implementation of Internal Market Provisions of Batteries and Accumulators Directive (2006/66/EC)
[93] GHK and BIO Intelligence Service, 2006, A study to examine the benefits of the End of Life Vehicles Directive and the costs and benefits of a revision of the 2015 targets for recycling, re-use and recovery under the ELV Directive, for DG ENV

2002/96/EC		■ Total burden across EU27 for registering and reporting activities ranges from EUR 36.7 million to EUR 42.8 million per year under the baseline assumption of 8 hours needed per report ■ The potential number of reporting activities across EU27 sums up to at least 72 reports to be delivered every year per producer ■ The start-up effects on costs (both technical costs and additional costs) are still significant across different MS. Technical costs include costs for collection, costs for transportation and costs for treatment. Total costs also include all additional costs such as kick back from distribution chain, costs for levying funds, communication, R&D costs, etc.
RoHS Directive 2002/95/EC	–	The administrative burden and associated costs for industry to comply with the RoHS Directive are relatively high. It has been estimated that average past and future one-off cost impact of RoHS lies between 1 and 2% of total company turnover. For comparison, electronics companies spend on average 4-6% of their revenues in R&D.[81] Compliance costs make up 67% of all costs made to comply with RoHS; the share of technical costs amounts to 33%. Within the future yearly costs to stay RoHS compliant, the share of technical costs drops to 12%, whereas compliance costs reach a level of 88% of total costs. As most technical costs (capital and R&D expenditure) were incurred in the past to comply with RoHS, the remaining future yearly costs consist mainly of the operating expenditure, such as increased purchasing costs of materials or higher energy costs, related to the substitution of RoHS substances. The relative cost burden is higher for SMEs.[81] There are unintended and potentially avoidable legal counselling and personnel costs for economic operators who need to track potentially diverging transpositions of the RoHS Directive and associated legislation (e.g. Commission decisions on exemptions).[94]
Batteries Directive 2006/66/EC	–	Data for Ireland (as an illustration): It is estimated that producer costs for the environmentally sound management of waste portable batteries and button cells following the achievement of mandatory targets and incremental progress leading up to and following the achievement of those targets will range from €3.8 million to €9.2 million over a 10 year period, ranging from €118,000 to €294,000 in the first year and €648,000 to €1.6 million in the tenth year of operation.[95] Additional administrative burden for companies arises from the various overlaps with the WEEE and ELV Directives.

[94] EC, Impact assessment of the RoHS Directive recast, 2008 (SEC2008) 2930
[95] Environment Heritage and Local governments (Ireland), 2008, Waste Management (Batteries and Accumulators) Regulations 2008 (S.I. No. 268 of 2008) Screening Regulatory Impact Analysis)

Costs for public authorities		
Packaging Directive 94/62/EC	+	Avoided public expenses to collect and treat packaging waste and build disposal infrastructure (although there are no detailed estimates on this aspect).
ELV Directive 2000/53/EC	+	Avoided public expenses to collect and treat ELVs and build disposal infrastructure (although there are no detailed estimates on this aspect). The Directive helped public authorities in the EU deal with the problem of abandoned vehicles and tackle vehicle crime (take back obligation). The requirement to issue Certificates of Destruction as a condition for deregistration improves information about the vehicle stock and helps establish accurate records.[78]
WEEE Directive 2002/96/EC	+	Avoided public expenses to collect and treat WEEE: more than 39,500 producers have registered and meet their financial producer responsibility obligations.[96] Avoided public expenses to build infrastructure such as landfill and incineration plants (although there are no detailed estimates on this aspect).
RoHS Directive 2002/95/EC	–	Enforcement officials in MS administrations who need clear rules and efficient tools for assessing product compliance and carrying out market surveillance are affected by the legal uncertainty of the RoHS Directive.[94]
Batteries Directive 2006/66/EC	+	Avoided public expenses to collect and treat waste batteries and build disposal infrastructure (although there are no detailed estimates on this aspect).
	–	Two MS indicated that the enforcement of the Batteries Directive currently costs them approximately € 200 000 per year. This sum may vary depending on how the Batteries Directive is implemented in each MS. Enforcement and monitoring costs can vary from one region to another within a MS.[97] UK example: According to the UK Department for Business, Innovation and Skills, the impact on the public sector is estimated to be in the region of about €56 400(£50,000) to about €225 400(£200,000) per annum to cover the costs of enforcing the regulation transposing provisions on batteries and accumulators in the UK.[92]

[96] EC, 2008, Commission Staff Working Paper accompanying the Proposal for a Directive of the European Parliament and of the Council on waste electrical and electronic equipment (WEEE) (recast) Impact Assessment {COM(2008) 810 final}

[97] BIO Intelligence Service, 2010, Study on Elements for an impact assessment on proposed options for capacity labelling of portable primary batteries in the context of the Batteries Directive 2006/66/EC, for DG ENV (http://ec.europa.eu/environment/waste/batteries/pdf/battery_report_june2010.pdf)

R&D, innovation		
Packaging Directive 94/62/EC	**?**	No information available
ELV Directive 2000/53/EC	**+**	The Directive has provided a more certain environment less sensitive to fluctuations in commodity prices. As a result, the Directive can be expected to promote economies of scale in treatment and recycling, and to encourage investment and innovation within the sector.[78]
WEEE Directive 2002/96/EC	**≈**	The direct impact of the WEEE Directive on innovation is rather limited. Regarding treatment technologies and recyclates markets, the availability of a secure stream of WEEE will probably help with the development of markets for recyclates.[98]
RoHS Directive 2002/95/EC	**≈**	The RoHS Directive is thought to have led to innovation in order to develop RoHS-compliant EEE, however no supporting data could be found. This is balanced by the fact that the RoHS Directive might lose its impact as a driving force for innovation when industry has the choice between developing alternatives for certain products and proposing an amendment of the legislation.[81]
Batteries Directive 2006/66/EC	**?**	No information available (MS must send the Commission reports on the implementation of the Directive and the measures they are taking to encourage developments affecting the impact of batteries and accumulators on the environment (including new recycling and treatment techniques); the first report will cover the period until 26 September 2012).

[98] BIO Intelligence Service et al., 2006, Gather, process, and summarise information for the review of the waste electric and electronic equipment directive (2002/96/EC), for DG ENV

3.3 Social effects

An overview of social effects associated with the waste stream Directives is provided in Table 11 below, under two main categories: health and jobs.

Table 11: Key social effects of the waste stream Directives

Legend: + positive effect; - negative effect; ? uncertain effect; ≈ no significant effect

Public health and occupational health		
Packaging Directive 94/62/EC	+	Expected health benefits through a reduced level of exposure to hazardous substances present in packaging, through the implementation of the "Essential Requirements", although there is no supporting data on this aspect.
ELV Directive 2000/53/EC	+	Expected health benefits through a reduced level of exposure to hazardous substances such as for example waste oils that are persistent and bioaccumulative, and heavy metals.[78] The entry into force of the Directive has led to improved environmental practices, with a reduced risk of waste oil spillages for example. It has also led to reduced levels of toxic substances in cars (e.g. mercury, chromium). This provides health benefits for workers handling those substances, consumers and the society at large.
WEEE Directive 2002/96/EC	+	Expected health benefits from improved treatment practices (reduced emissions); however, solid evidence that the implementation of the WEEE Directive has resulted in any new measures in companies/organisations affecting health and safety standards is not yet available.[80]
RoHS Directive 2002/95/EC	+	Expected health benefits from a reduced level of exposure to hazardous substances for workers producing and handling those substances, consumers handling the EEE and the society at large. For example, brominated flame-retardants tend to volatilise from products during service life and may generate health impacts. Release of 150 t of octa-BDE in the environment during use of EEE has been avoided and the use of 179 t of deca-BDE was expected to be avoided (the quantities were estimated per product/year and summed up over the total lifetime of products, for the number of products in the EU25).[81]
Batteries Directive 2006/66/EC	+	Expected health benefits through a reduced level of exposure to hazardous substances potentially released during the life-cycle of batteries (mercury, cadmium, lead, etc.), although there is no quantitative data to illustrate this point.
Jobs		
Packaging Directive 94/62/EC	+	The direct employment in packaging recovery operation has been estimated at 30,000 Full Time Equivalent (FTE)/year and the first round indirect employment at 12,000 FTE/year.[99] The direct and first round indirect employment rate in the packaging recovery and recycling industry is estimated at 42,000 FTE. This number needs to be compared with possible job losses in the waste disposal sector as a result of macroeconomic

[99] Pira Ecolas, 2005, Study on the implementation of Directive on packaging and packaging waste and options to strengthen prevention and preparation for re-use of packaging, for DG ENV

		effects (the funds spent on recycling are not available for spending on other economic activities – such effects will decrease as disposal costs increase). It is unclear how many jobs may have been affected as a result of these effects. Overall, the employment balance is likely to be neutral or slightly positive.[74]
ELV Directive 2000/53/EC	**+**	Direct and indirect job creation effect of the proposed ELV directive was estimated at 6,100 FTE jobs in 2005 and 18,500 jobs in 2015.[100]
WEEE Directive 2002/96/EC	**+**	The income generated by the collection and dismantling of WEEE is often referred to as a good job opportunity for disadvantaged people in the first labour market. Several national studies illustrate that that WEEE dismantling appears particularly suitable to integrate long-term unemployed and disabled.[80] Significant investments were made in treatment facilities (new facilities in the EU-15 plus new treatment facilities serving several new MS at the same time) and the WEEE recycling business increased to a multi-billion industry, employing several tens of thousands of persons[96].
RoHS Directive 2002/95/EC	**+**	Generally, job creation for RoHS compliance consists of a mix of permanent and temporary jobs. In some cases, a separate job was created e.g. staff for database maintenance and operation, corporate RoHS Program Manager, new contractor to manage transition of materials supply and stock from non-RoHS to RoHS compliant. In other cases, additional administrative tasks have been added to existing jobs e.g. control of production processes to ensure RoHS compliance.[81]
Batteries Directive 2006/66/EC	**?**	No information available

3.4 Conclusions

Overall, the waste streams Directives appear to have provided significant environmental benefits from an environmental point of view, although higher environmental benefits could be achieved by increasing collection and recycling and continuing efforts to divert waste from landfilling and incineration.

On the economic side, the waste streams Directives have enabled public authorities to reduce waste collection and treatment costs for the waste streams of concern. Compliance with producer responsibility requirements and other legislative requirements of the waste streams Directives have generated significant administrative costs for the private sector, although such costs are to some extent integrated in the price of products placed on the market. The implementation of the waste streams Directives has brought significant benefits to the waste recycling industry, through the establishment of minimum recycling targets.

With regard to social effects, information is not always available but it seems overall, the Directives have contributed to job creation: levels of material recycling have increased, leading to the development of new markets with associated jobs. Recycling creates more jobs than any other treatment option as highlighted by a 2010 report from Friends of the Earth "*On a European*

[100] Ecologic, 2004, Job Creation Potential of Clean Technologies

level, if a target of 70% for recycling of key materials was met, conservative estimates suggest that across the EU27 up to 322,000 direct jobs could be created in recycling an additional 115 million tonnes of glass, paper, plastic, ferrous and non ferrous metals, wood, textiles and bio-waste. These jobs would have knock on effects in down and upstream sectors and the wider economy and could create 160,900 new indirect jobs and 80,400 induced jobs. The total potential is therefore for more than 563,000 net new jobs[101]". The 2005 Thematic Strategy on the Prevention and Recycling of Waste underlines that in total the waste management and recycling industries were considered to provide between 1.2 and 1.5 million jobs in the EU[102]. In addition to jobs in the recycling sectors, new types of jobs have been created to monitor industry's compliance with product design requirements, in particular the RoHS requirements.

Concerning the coherence between Directives, harmonising the five waste stream Directives and the WFD would likely provide additional environmental benefits while reducing implementation costs for companies and MS. If the five waste stream Directives referred explicitly to a common set of core rules including common key definitions, a unique EPR scheme basis, and the waste hierarchy included in the WFD, this would likely result in reduced administrative burden for the implementation and transposition of possible new waste stream Directives and in more stringent requirements and a higher level of ambition[103]. Integration of strengthened ecodesign requirements is also an important parameter that could improve the cost-effectiveness of the waste stream Directives. However, it is important to note that there are limits to the level of harmonisation to be achieved in order to improve the efficiency of the waste stream Directives, as they cover different and very specific waste streams as well as have different legal bases.

Besides, specific incoherence between related pieces of legislation must be addressed in order to avoid issues such as legal uncertainty or double regulation. For instance, imprecise scope of certain Directives or unclear relations between different pieces of legislation (e.g. unclear scope of RoHS, unclear relation between REACH and RoHS and lack of clarity of relation between WEEE and RoHS) has led to law breaches, market distortions and has generated additional costs for economic operators. The links between the WEEE and RoHS Directives and also the REACH Regulation are currently being clarified in the WEEE and RoHS Directives recasts[104].

Many of the stakeholders consulted shared the opinion that, in addition to improved coherence between the waste stream Directives and the WFD, an important issue to be addressed to improve cost-effectiveness is the consistency of transposition between MS. Indeed, significant costs and administrative burden for companies result from inconsistencies in legal requirements across MS, due to differences in the Directives' transposition.

[101] Friends of the Earth, 2010, More jobs less waste

[102] EC, 2011, Commission Staff Working Paper Accompanying the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the Thematic Strategy on the Prevention and Recycling of Waste

[103] In line with this reasoning, the Proposal for a Directive of the European Parliament and of the Council on WEEE Recast introduces a direct reference to the WFD. The article states that "this Directive supplements the general EU waste management legislation, such as Directive 2008/98/EC of the European Parliament and of the Council on waste". It refers to the definitions of the Directive including the definitions of waste and general waste management operations.

[104] Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment entered into force on 21 July 2011

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Chapter 4: Key challenges for future waste legislation

In brief: Current implementation levels for all Directives examined (Packaging, ELV, WEEE and Batteries) are medium, indicating encouraging signs but insufficient data or mixed results among MS. A first challenge is therefore to address a number of barriers to the proper implementation of the waste stream Directives. Both the Landfill Directive and the Waste Shipment Regulation include provisions that may influence recycling in a positive manner; further enforcement is anticipated to contribute to higher recycling performance but is only one part of the solution, as demonstrated in MS where more ambitious policies have been implemented. Finally, waste streams Directives seem to be flexible and adaptable enough to take into account future changes of a technical and scientific nature while the main challenge will be the integration of new concepts in the waste stream Directives (waste hierarchy, life-cycle thinking, resource efficiency, ecodesign). Nanomaterials are one particular example of new types of materials that can be found in waste in increasing quantities and may require an adaptation of EU waste policy given their potential health and environmental risks. Beyond the challenge of defining nanomaterials, the policy actions should focus on compiling information on nanowaste flows, promoting labelling of products containing nanomaterials and imposing requirements to facilitate dismantling of product parts containing nanomaterials in order to facilitate re-use and recycling.

This chapter provides an analysis of future challenges for the further development of EU legislation on recycling, covering three main aspects: the obstacles to proper implementation and enforcement of the waste stream Directives; the impact of increased enforcement of corollary acquis such as the Waste Shipment Regulation and the Landfill Directive on recycling performance; and the adaptability potential of the present waste stream Directives. In addition, the specific case of nanomaterials is analysed to illustrate some of the aspects related to the adaptability potential of EU legislation on recycling, since it is a new type of material raising new questions.

4.1 Obstacles to implementation and enforcement of recycling acquis

This section provides a synthesis of the practical and political obstacles for the proper implementation and enforcement of the EU recycling acquis. The emphasis is placed on obstacles that may hinder the efficiency of previously identified drivers (as discussed in Section 2.2 on page 37 of the report).

4.1.1 Overview of current implementation level

An overview of the general state of implementation of the four waste stream Directives that contain specific recycling objectives is provided in Table 12 below.

Table 12: Summary of policy implementation levels[105]

Directive	Date of entry into force	Transposition deadline	Key issues
Packaging Directive (94/62/EC)	31 Dec. 1994	27 Jun. 1996	Most targets met, but lack of emphasis on prevention
End-of-Life Vehicles Directive (2000/53/EC)	21 Oct. 2000	21 April 2002	Infringement cases pending, some data missing
WEEE Directive (2002/96/EC)	13 Feb. 2003	12 Aug. 2004	Most MS have met collection targets, recycling/re-use and recovery targets; however, some data missing and one infringement cases
Batteries Directive (2006/66/EC)	26 Sept. 2006	28 Sept. 2008	Lack of data before 2012, mixed results from MS so far

The overall implementation level of the Directives, at EU level, can be considered as medium. Recycling levels are rising across the MS; however, often at very different rates and from different baselines, depending on the MS considered. There is strong evidence that targets for recycling in the EU recycling acquis have driven significant improvements in levels of recycling across the EU.[106] While EU-15 MS with high baseline recycling rates (40-50%) experienced yearly percentage increases over the period 2000-2006, since 2004 evidence indicates performance has stabilised in several MS. In the EU-12, recycling rates are more disparate.

Recycling performance also varies by waste stream, for example:

- As of 2008, 61% packaging waste was recycled in the EU-27, a recycling rate above the 55% target for 2008 in the Packaging Directive; 15 MS reached the 2008 target, 12 others having transitional periods.[107,108]
- As of 2007, most MS had met or exceeded the ELV 2006 target of 80% reuse/recycling.
- The average WEEE recycling rate in 2008 was 76% with approximately 70% of WEEE put on the market reported as collected.
- In 2008, around 18% of batteries placed on the market were recycled, in comparison with a 2012 target for 25% collection (and 100% recycling of collected amounts).

[105] BIO Intelligence Service et al., 2011, Implementing EU waste legislation for green growth – Interim Report, for DG ENV (http://greengrowth.eu-smr.eu/)
[106] IEEP, BIO Intelligence Service et al., 2010, Final Report – Supporting the thematic strategy on waste prevention and recycling, for DG ENV (http://eu-smr.eu/tswpr)
[107] For example, Greece's deadline is 2011, Cyrpus and Lithiania's deadline is 2012, Latvia's deadline is 2015.
[108] Eurostat, 2008, Packaging waste
http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/data/wastestreams/packaging_waste

4.1.2 Obstacles to enforcement and implementation

Overall obstacles to proper implementation and enforcement of the waste stream Directives are outlined in Table 13 below.

Table 13: Main barriers to implementation and enforcement [105]

Directive	Barriers to implementation and enforcement
Packaging Directive (94/62/EC)	■ The definition of what is or not packaging waste was cited as an important challenge and a complex issue to address. In particular, differing interpretations among MS make it complex for companies operating in several MS. ■ Inconsistency in terms of point at which achievement of recycling and recovery targets should be measured.[109] ■ Difficulty in ensuring that packaging which seeks to fulfil recyclability criteria is actually recycled. ■ Vagueness of some CEN standards developed to comply with Essential Requirements. ■ Lack of focus on enforcement of Essential Requirements by MS officials in part due to lack of clarity on how to measure practical application. Only 3 MS out of 27 have mechanisms in place to monitor compliance with the Essential Requirements, meaning that in most countries there is no efficient way of assessing their effectiveness. ■ Difficulty in ensuring separate collection of packaging waste apart from other waste leads to practical financing difficulties: producers pay for collection and recovery, including recycling in principle, but treatment of packaging found in residual waste is actually paid for by public authorities. ■ Complexity of operative aspects of financing scheme involved with the Packaging Directive, linked with shift of cost responsibility from public authorities to the co-financing by the private sector. ■ Insufficient reliability and extent of data on implementation across MS. ■ Some stakeholders mentioned insufficient technical expertise in responsible public administrations in some MS.
End-of-Life Vehicles Directive (2000/53/EC)	■ Difficulty in tracking what happens to ELVs once they are removed from registration (those vehicles treated in the EU account for only a fraction of vehicles removed from registration). In general there are different approaches to the de-registration of vehicles across MS. In some MS, the number of Certificates of Deregistration issued is not equal to ELVs arising. This is due to the fact that a vehicle can be de-registered before the car owner decides that his/her car becomes waste. ■ Lack of focus on removal of heavy metals such as mercury or other hazardous substances that may contaminate fluff and therefore prevent from achieving optimal recycling rates. ■ Difficulty in distinguishing between ELVs and used cars, leading to illegal exports of ELVs. The question of when a used car ceases to be a product and becomes waste according to the WFD is answered in different ways across MS. As a consequence, there are problems regarding the comparability of the reported data and in individual cases regarding the answer to the question if a transboundary shipment of a vehicle is subject to the provisions of the EC Waste

[109] While the European Court of Justice specifies that recycling and recovery targets are fulfilled only once actual recycling has taken place (ECJ Case C-444/00 Mayer Parry), the Waste Framework Directive (2008/98/EC) and the Manual on waste statistics indicate that waste can be considered as recycled after the sorting phase, due to the practical difficulties of tracking waste sent to final treatment facilities.

Directive	Barriers to implementation and enforcement
	Shipment Regulation No 1013/2006. ■ Lack of clarity on the classification of treatment operations for "recycling", "recovery" and "disposal". ■ Overall trend to reduce maximum allowable levels of hazardous substances in products through the application of REACH Regulation. Should allowable levels in recycled products be reduced in the same way as in new products, this may prevent some recycled materials from being placed on the market and may therefore hinder recycling activities. ■ Persistence of non-authorised treatment operators, contributing to an uneven playing field.
WEEE Directive (2002/96/EC)	■ Due to the small size of some EEE, consumers are not incentivised to turn in such objects. ■ The variety of materials used means not all MS have proper treatment facilities for all types of WEEE materials; this results in increased transportation costs. ■ Differences in calculating recovery and recycling rates across MS. ■ An increasing variety of chemical elements are used in EEE; low concentration of materials and high diversity make recovery less economically viable and lead to the generation of less revenues for financing a separate collection system. ■ Exemptions to monitoring requirements. ■ Free-riders who do not register or fulfil their financial obligations to a full extent are an obstacle to the full implementation of producer responsibility and an obstacle to fair competition.
Batteries Directive (2006/66/EC)	■ Areas of overlap with the WEEE and ELV Directives are problematic, in particular with regard to EPR provisions and data reporting obligations. ■ Lack of a clear methodology for calculating recycling efficiency. ■ Due to the small size and economic value of individual batteries, consumers are not much incentivised to turn in batteries. ■ Diversity of stores that sell batteries makes arranging collection systems complex. It may also be difficult for consumers to identify where take-back points are located. ■ Complexity of accounting system for the transfer of costs from producers/retailers to waste treatment organisations. ■ Lack of producer responsibility specifications for second life batteries leading to uncertainty on financial transfer required from second user/retailer towards treatment outlets. ■ Difficulty of tracking amounts of batteries put on the market, complicated by households storing batteries for future use. ■ Lack of clarity on practical implications of "best treatment" required when exporting batteries outside of the EU.

In addition to the above obstacles, there are broader obstacles that apply across all Directives, as follows[110]:

- Lack of clarity on definitions and how to consider achievement of targets

[110] Partly based on: BIO Intelligence Service et al., 2011, Implementing EU waste legislation for green growth – Interim Report, for DG ENV (http://greengrowth.eu-smr.eu/)

- Complexity of setting up a collection system when none currently exists
- Lack of public awareness on existing collection systems
- Variety of capacities to comply with recycling requirements across MS, depending on facilities, staff and budget available
- Difficulty of ensuring passage of collected waste through a chain of certified operators for treatment[111]
- Diversity of implementation strategies among MS, with differing interpretations of requirements that are not harmonised across the Directives or of the links between the Directives (e.g. interpretations concerning the overlaps between WEEE and Batteries Directives)
- Fluctuations in price of secondary raw materials and difficulty of regulating such markets at EU level
- The existence of some recyclers producing non-compliant secondary materials with excessive concentrations of hazardous substances was mentioned during the stakeholder consultation as an issue resulting in unfair competition.
- Lack of inspections at MS level to check compliance with legal provisions
- Lack of dissuasive sanctions in instances of non-compliance (non compliance of operators, non compliance of MS)
- Lack of awareness on innovative sorting techniques (significant progress has been made in the development of these technologies, in recent years)
- The tendency among local authorities and national waste management schemes to invest primarily in the collecting and sorting of waste fractions representing the largest volumes or quantities (since the recycling targets are based on weight), sometimes to the detriment of smaller waste fractions which may be highly valuable to recover (e.g. metals) and may generate significant resource wastage if not recycled.
- Some emerging waste treatment technologies such as pyrolysis or gasification are difficult to classify within the treatment categories defined in current legislation, since they can be considered as hybrids of recycling and energy recovery.

4.1.3 Potential policy actions to address obstacles

Several policy actions can be envisaged to address obstacles related to implementation and enforcement, which must, of course, be adapted to national and local contexts. While an analysis of all possible actions is outside the scope of this study, some priority actions can be identified with regard to the broader obstacles identified; these are:

[111] According to recycling organisations, a significant proportion of collected waste is likely to be treated in non-certified facilities. A high proportion of WEEE is processed to recover valuable metals only, without a proper depollution or recycling/recovery treatment. In addition, valuable metals such as copper are reported to be frequently stolen before even reaching a certified recycling facility. In France, cash payment for metals will be forbidden in the near future in order to limit metal theft. The EU is promoting similar rules, which could be useful to protect the "green" recycling industry, in addition to limiting metal losses to non-EU countries.

- Awareness-raising and communication-related actions
  - Communication campaigns to encourage participation by consumers, including making consumers aware of the negative impacts of non-recycling
  - Measures to improve local authorities' awareness and understanding of the latest developments in sorting, separation and end-of-life options for waste streams, with possible development of standards on sorting techniques in order to differentiate the performance of the various technologies currently available.
  - Encouraging sharing of best practices across MS
- Enforcement-related actions
  - Exploration of tools for increasing enforcement to ensure MS compliance
  - Increased sanctions in cases of non compliance
  - Better monitoring of MS waste management plans by the Commission to ensure appropriateness
- Inspections-related actions
  - Inspections on the compliance of recycled materials with regard to allowable levels of hazardous substances
- Other priority actions
  - Creation of approved collection systems for which producers can sign up to reduce complexity and encourage participation in collection schemes
  - Support to the further development of markets for secondary raw materials

In the case of the ELV Directive, a well-functioning deregistration system, including the use of a certificate of destruction (CoD) is important to improving implementation; furthermore, vehicle registration could be linked to national registration systems, if not already connected.

There are many examples highlighting the fact that consumers' understanding of market factors can influence achievement of recycling targets. During the stakeholder consultation, it was also highlighted that consumers play an essential role in achieving separate waste collection and this must be taken into account with more thinking into how to create incentives for consumers.

Incentivising collection is also a challenge for effective implementation of the WEEE Directive. In its current form, the Directive includes a collection target of 4 kg of WEEE per person per year from private households. Up from previous estimates, as of 2008 the collection rate of WEEE in the EU-27 was 70% or an estimated 6.4 kg per person.[112] When WEEE is separately collected,

[112] Eurostat, 2009, WEEE – Key statistics and data (http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/data/wastestreams/weee)

recycling rates are high, around 79%.[113] This indicates that to achieve the objectives of the Directive and the overarching goal of increased resource efficiency, it is key to focus on implementation mechanisms to boost collection of WEEE. It is important not only to ensure that a system of free-of-charge take-back points are put in place, but also that efforts are undertaken to encourage consumers to actively seek opportunities to turn in WEEE. Awareness raising efforts should include informing consumers about the environmental consequences of discarding WEEE improperly, educating them about existing possibilities for turning in WEEE for recycling and highlighting the ease with which they can participate in such take-back schemes.[114] Such activities could be undertaken by local authorities, producers, consumer associations and NGOs, individually or in partnership.

A similar issue exists with the Batteries Directive. Making customers aware of the negative impacts of improper treatment of batteries, especially in relation to hazardous substances, the economic value of the resources contained in batteries, educating on proper drop off points for batteries, and discouraging hording behaviour is key to ensuring high levels of collection and recycling for batteries and accumulators.[115] During the stakeholder consultation, the necessity of incentivising turn in of batteries was discussed as separate collection for such small objects is difficult; using a deposit system is an option but lifetimes of batteries are too long (between 6 to 8 years) and it is difficult to calculate return rates due to the large quantities of batteries stored in households which are no longer on the market but are not either considered as waste.

4.2 Influence of Landfill Directive and Waste Shipment Regulation on recycling

This section discusses the impact of corollary acquis such as the Landfill Directive (1999/31/EC) and the Waste Shipment Regulation (EC No 1013/2006) on recycling performances. In particular, it seeks to assess whether an increased enforcement of these corollary acquis would likely result in higher recycling levels. In the next paragraphs, first of all the influence of the Landfill Directive and the Waste Shipment Regulation on recycling is analysed, then enforcement issues with regard to these two instruments are highlighted, in order to draw some conclusions as to the potential recycling benefits of stricter enforcement measures.

The move towards a "recycling society" relies not only on the correct implementation of the waste stream Directives and the WFD but also on an adequate implementation and enforcement of the corollary acquis. A Commission report confirms that the lack of proper implementation continues to cause widespread failure in achieving the environmental protection objectives and shows significant disparities between MS. At the end of 2009, waste represented on average 20%

[113] EEA, November 2010, State of the environment report: material resources and waste http://www.eea.europa.eu/soer/europe/material-resources-and-waste

[114] UNU, AEA, REC, Gaiker, and TU Delft, 2007, 2008 Review of Directive 2002/96/EC on waste electrical and electronic equipment (WEEE) http://ec.europa.eu/environment/waste/weee/pdf/final_rep_unu.pdf

[115] BIO Intelligence Service, 2003, Impact Assessment on Selected Policy Options for the Revision of the Battery Directive, for DG ENV (http://ec.europa.eu/environment/waste/batteries/pdf/eia_batteries_final.pdf)

of all environmental infringement cases[116]. With full implementation of existing acquis, waste recycling would be expected to increase from 40% in 2008 to 49% in 2020[116]. The Landfill Directive and the WSR are two legislative instruments for which significant enforcement gaps have been noted (landfills that do not meet EU requirements, unauthorised landfills, illegal waste shipments, etc.)[117].

4.2.1 Enforcement of the Landfill Directive

Influence of Landfill Directive on recycling

The Landfill Directive lays down requirements for waste to be disposed of in landfills. The implementation of the Directive may contribute to the achievement of EU legislation concerning recycling in two main ways:

- MS had to formulate strategies on how to reduce biodegradable waste going to landfills: by 2006 (or 4 years later for some MS having derogation) the amount of biodegradable waste going to landfills had to be reduced to 75% of 1995 levels and to 50% by 2009. Via these targets, inter alia the recovery and recycling of the organic fraction is promoted in an indirect fashion by the Landfill Directive while organic waste ("bio-waste") is so far not subject to a separate waste stream Directive. One of the main purposes and benefits of the reduction of biodegradable waste from landfill is to reduce methane emissions, an important cause of the greenhouse effect and far more harmful to the climate than CO_2.
- It bans the landfilling of certain types of waste streams, in particular tyres (with limited exceptions). The banning of the landfilling of certain substances gives an indirect incentive to MS to promote recycling and recovery, but also potentially incineration as disposal measure.
- It prohibits landfilling of untreated waste (Article 6a), the objective of treatment being to "*reduce the quantity of the waste or the hazards to human health or the environment*"

The Landfill Directive can have beneficial effects on recycling if an optimal separation of recyclable fractions of waste is ensured upstream, and if these fractions are actually recycled instead of being landfilled. Resource efficiency is ensured when landfilling is used as the ultimate options, only for waste that cannot be reused or recycled.

The Directive may also indirectly improve the recovery and recycling of ELVs and large WEEE through the elimination of illegal dumping sites, especially in those MS with large numbers of such illegal landfills.

Potential improvements in terms of recycling performances also come from the fact that a number of MS went beyond the Directive's requirements: they adopted landfill bans for additional waste fractions, as well as landfill taxes, to encourage the diversion of waste from

[116] EC, 2011, Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions on the Thematic Strategy on the Prevention and Recycling of Waste SEC (2011) 70 final

[117] Milieu, Ambiendura and FFact, 2009, Study on the feasibility of the establishment of a Waste Implementation Agency, for DG ENV

landfill (see Table 14 below). In addition to the types of waste specifically targeted by the Directive (bio-waste, tyres), the recycling of additional types of waste can be encouraged by specific landfill taxes and bans going beyond the Directive's requirements (e.g. packaging waste, batteries).

Table 14: Landfill taxes and bans in place in the EU Member States[118, 119]

Country	Landfill tax implemented or planned in €/t	Landfill ban implemented or planned (beyond Landfill Directive)
Austria	87 (from January 2006) –depending on composition of waste and standard of landfill Prices adjusted in line with inflation	Total organic carbon (TOC) >5% from 2008. Exceptions for landfilling outputs from MBT[120] (separate standards)
Belgium (Flanders)	29.71 - 42.44 (from2010, non combustible waste) 55.70 - 79.56 (from 2010, combustible waste) Ranges exist due to private/public landfill sites Prices adjusted in line with inflation	TOC>6% Bans on sorted and non sorted waste for recovery, on combustible residual fraction for sorting
Belgium (Wallonia)	65 (2010, hazardous waste) 60 (2010, non hazardous waste) Prices adjusted in line with inflation	Ban enacted since 2004
Denmark	63 (for 2010 - 2011)	From 1997, ban on waste suitable for incineration
Netherlands	107.5 (from 2010)	For 35 categories of waste
Sweden	40	Sorted combustible waste from 2002. All organic waste from 2005.
Germany	None (total landfill ban instead)	
Czech Republic	17 (from 2009)	
Finland	30 (exceptions for private landfills, fly ash, waste used in construction of landfills)	Aim for transitional ban on biodegradable municipal waste from 2011
Ireland	30 (from 2010) Under review – higher landfill tax expected	Some landfills ban certain waste streams but no national legislation
Italy	1-25 (depending on type of waste, e.g. inert, MSW)	Possible ban on combustible waste from 2011

[118] EC, 2011, Commission staff working document accompanying the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the Thematic Strategy on the Prevention and Recycling of Waste
[119] IEEP, BIO Intelligence Service et al., Use of economic instruments and waste management performances - ongoing study for DG ENV (http://ei-waste.eu-smr.eu/)
[120] Mechanical Biological Treatment

Country	Landfill tax implemented or planned in €/t	Landfill ban implemented or planned (beyond Landfill Directive)
Luxembourg	From 123.95 (household waste) to 175 (commercial waste)	
France	11 - 20 The tax is adjusted based on the sites' environmental performance Plans are for the tax to increase as follows: 2012 -2013 : from 15 to 30 In 2014 : from 20 to 30 In 2015 : from 20 to 40	Introduced in 2002 on non-residual wastes (definition of residual under discussion)
UK	35.2 (from 2007) 3.7 (inert waste) Rising by 11,72 per annum then top rate of 82,60 from 2013/2014	None at present but there is a consultation for a future ban
Hungary	7-15 (from 2010, exceptions for certain types of waste)	Tyres from 2004, rubber scrap for 2006
Poland	25 for mixed waste from 2012: 35 from 2013: 40 from 2014: 45 from 2015: 50 Can be negotiable in some municipalities.	
Portugal	3.5 (updated each year)	No
Spain	Variable according to the region. The tax rate depends on the type of waste and is applicable to the volume of waste landfilled: - Hazardous waste: 10-15 - Non hazardous waste (excluding C&D waste): 7 - C&D waste: 3 €/m^3	No

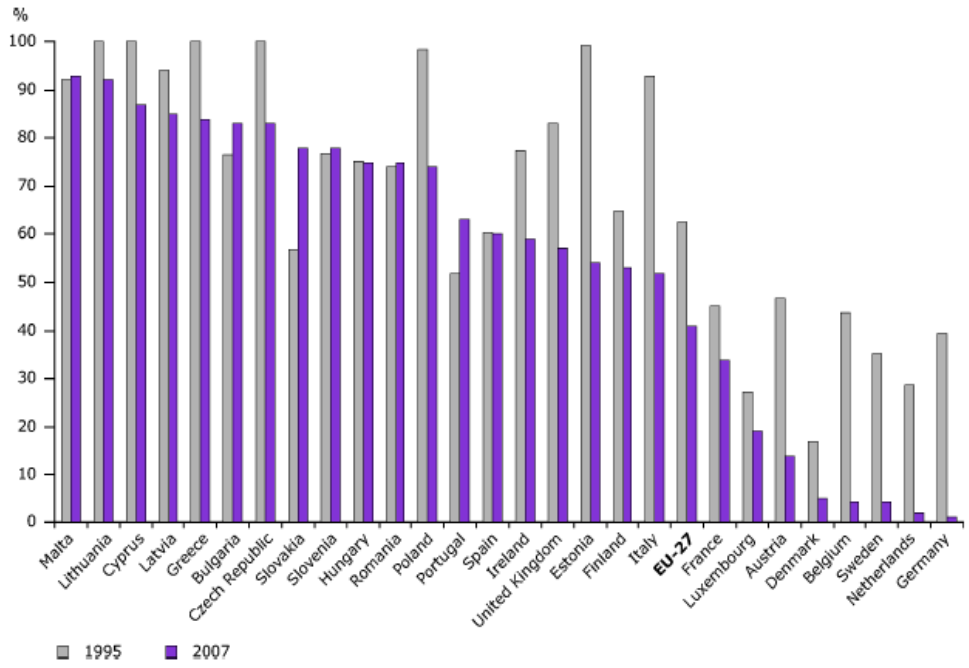
Implementation status

Large implementation and enforcement differences persist between MS. Depending on the targets and the waste streams, some MS have gone far beyond achieving the minimum EU recycling or landfill diversion targets although others will have to make additional efforts to respect the EU requirements[121].

[121] EC, 2011, Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions on the Thematic Strategy on the Prevention and Recycling of Waste SEC (2011) 70 final

Overall, the majority of the MS have reduced the amount of municipal waste disposed of in landfills between 1995 and 2007 (see Figure 11 below). Over that time, six MS (Bulgaria, Malta, Portugal, Romania, Slovakia and Slovenia) increased their disposal of municipal waste in landfills. There are clear differences between MS, especially between the EU-12 and the EU-15 MS. For example, in 1995, an average of 62% of municipal solid waste was landfilled in the EU-15 in contrast with the 87% average in the EU-12. By 2007, the above figures had fallen to 42% and 79%, respectively[122].

Figure 11: Percentage of municipal waste that is landfilled in the EU-27, 1995 and 2007[122]



The application of targets of the Landfill Directive has contributed to increased recovery of resources from waste by progressively diverting certain wastes from landfills. However, bio-waste management in the EU still has not realised its full potential, therefore the 2010 Communication on bio-waste management in the EU18 proposes further action and notably the production of guidelines on bio-waste prevention and on applying life-cycle thinking to bio-waste management[123].

In the EU-15, data from 2005[124] shows that municipal solid waste quantities continue to increase. However, with the exception of Greece, the amount of municipal solid waste being landfilled by the MS was in most cases decreasing or, at worst, levelling off. In most MS, the number of permitted or legal landfills appears to have declined since the implementation of the Landfill Directive. This decline is partly attributable to the implementation of the Directive itself[124]. This

[122] EC, 2011, Commission staff working document accompanying the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the Thematic Strategy on the Prevention and Recycling of Waste

[123] EC, 2011, Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions on the Thematic Strategy on the Prevention and Recycling of Waste SEC (2011) 70 final

[124] Golder Europe EEIG, 2005, Implementation of the Landfill Directive in the 15 Member States of the EU (ec.europa.eu/environment/waste/pdf/report_a2.pdf)

should be qualified by recognising that most MS have implemented their own national strategies that call for increased waste minimisation, reduction, recycling and treatment of residues.

Indeed, countries that implemented additional initiatives to divert waste from landfill seem to have achieved higher recovery and recycling rates. For instance, in the Netherlands, the landfill tax has contributed to a 60% decrease in the amount of waste landfilled between 1996 and 2004. Over the same period the amount of waste incinerated increased by 50% and the recycling rate increased by approximately 20%[125].

In countries with high levels of material recovery, a ban on the landfilling of waste with organic content has been an effective measure to reduce the amount of municipal waste going to landfill. Germany, Sweden and Austria all experienced a reduction in landfilled waste the first year after such bans were put in place. A similar albeit slower response was observed in Denmark. In all four countries, this diversion is supported by other measures: separate collection systems for packaging waste and landfill tax. In Hungary, a package of measures comprising a landfill ban and separate collection systems for packaging waste seems to be producing results, while in the Netherlands and Slovenia a combination of landfill bans, landfill taxes and separate collection systems for packaging waste seems to be diverting waste successfully[126]. Within this group of countries, only Germany, Austria, and Hungary show both a high level of material recovery and incineration. The predominance of recycling over incineration is explained by several factors including strong waste policies adopted before the Packaging Directive and which served as drivers for the rest of Europe to follow and adopt the Packaging Directive. However, recent increases in incineration levels mean that Austria and Germany were about to become countries with high material recovery and incineration (above 25%) in 2007; a trend likely to be reinforced by landfill bans on biodegradable waste in both countries effective from 2004 and 2005 respectively. Other countries with a high level of material recovery (Sweden, Germany, and the Netherlands) also show a high level of incineration.

In France, a recent Decree[127] establishes the limits to the capacities of incineration and landfilling facilities at the department level: these capacities shall not exceed 60% of estimated non-hazardous waste (expect inert waste) collected within the area.

As regards illegal landfill sites in the EU-15, the information is often sparse and incomplete, considering also that the definition of "landfill" in the Landfill Directive varies within the legislation of each MS. During the implementation study of 2005[128], ten MS[129] reported zero illegal landfill sites and highlighted that they had had other legislation in place for many years requiring the permitting of landfills while six MS[130] highlighted the existence of illegal landfills on their territory. The reason why these six MS had relevant data is that they had put in place

[125] EC, 2011, Report from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the regions on the Thematic Strategy on the Prevention and Recycling of Waste SEC (2011) 70 final
[126] EEA, 2007, The road from landfilling to recycling: common destination, different routes (www.eea.europa.eu/publications/brochure_2007_4)
[127] Decree of 12 July 2011
[128] Golder Europe EEIG, 2005, Implementation of the Landfill Directive in the 15 Member States of the EU (ec.europa.eu/environment/waste/pdf/report_a2.pdf)
[129] Austria, Belgium-Flemish, Denmark, Finland, Germany, Luxembourg, Netherlands and the UK
[130] Belgium-Walloon, France, Greece, Ireland, Italy, Portugal, Sweden, Spain

specific legislation that identifies the problem of illegal landfills and provides for specific parties to take action, often including the task of setting up a database. It leads to the conclusion that the way MS measure and report illegal landfilling is not comparable and does not provides a comprehensive picture of illegal landfilling in the EU-27. According to a study performed in 2007[131] covering new MS (Czech Republic, Cyprus, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, Slovenia), none of the MS had a comprehensive inventory of illegal landfills, perhaps with two exceptions (Cyprus and Malta).

Since the 1980s, Cyprus experienced the opening of an increasing number of illegal landfilling and dumping sites that led authorities to take measures to identify the illegal landfill sites and improve the implementation of the Landfill Directive. The box below provides a short summary of the main actions taken and benefits obtained.

Box 4: Effects of Landfill Directive implementation in Cyprus

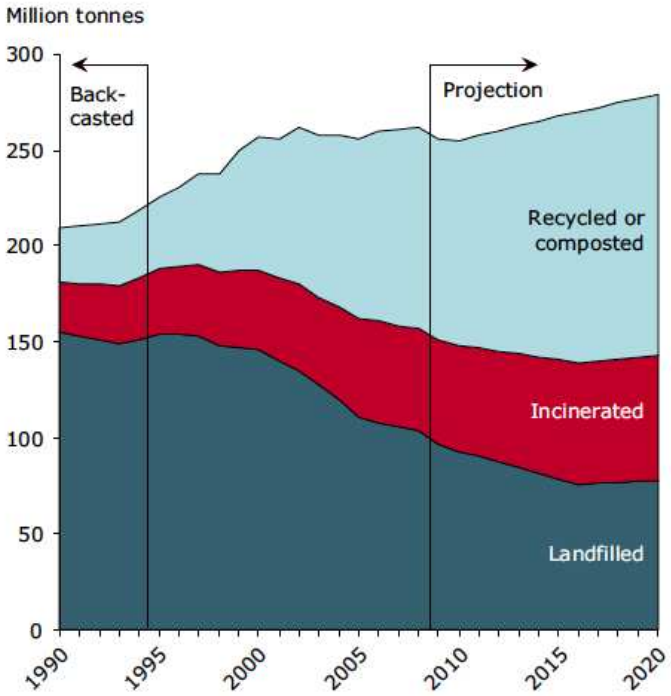
In 2004, the Ministry of the Interior commissioned a study on the identification and risk assessment of illegal landfills, which located 113 unofficial and uncontrolled dump sites and ranked their environmental and health risks, in order to focus closure efforts on the most problematic zones. This initiated a programme of landfill closure and installation of state-of-the-art treatment plants, combined with the installation of green points for separate collection.

The closure and rehabilitation of illegal landfill sites in Cyprus has led to increased usage of the legal collection, treatment and disposal system, and thus more effective resource use. The separate collection points as well as the state-of-the-art sanitary plants installed in Cyprus allow for increased recycling and waste recovery, with landfilling as a last resort. While in 2003 waste disposal in Cyprus was nearly entirely landfill, by 2007, approximately 20% of waste was recycled.

Figure 12 below provides projections of the amounts of municipal waste landfilled, incinerated, recycled and composted by 2020. According to a model developed by the EEA and its European Topic Centre on Sustainable Consumption and Production, if the historic trends in the development of the shares of recycling and composting, incineration and landfill are used to project waste management until 2020, recycling of municipal waste would increase from 40 % in 2008 to 49 %, while landfill would stabilise at around 28 %. This model does not take into account any additional prevention policies or better implementation of the corollary acquis.

[131] COWI, 2007, Follow-up study on the implementation of Directive 1999/31/EC on the landfill of waste in EU-25, for DG ENV

Figure 12: Trends and outlook for management of municipal waste in the EU-27 (excluding Cyprus) + Norway and Switzerland, baseline scenario[132]



In summary, the Landfill Directive seems to have contributed to increased levels of recycling; however, countries where the diversion of waste from landfilling to recycling has been successful have generally been put in place additional policy measures such as measures going beyond the Directive's requirements (e.g. landfill taxes, additional landfill bans), measures specifically targeted at improving separate collection and recycling or measures imposing limits to the capacity of waste incineration infrastructure. Projections on the mid-term show that recycling is expected to increase, and could increase even more if the corollary acquis were better implemented or reinforced by additional policy instruments.

Potential benefits from increased enforcement

Increased enforcement of the Landfill Directive (i.e. increased controls, compliance measures and sanctions) could lead to increased incineration – with or without energy recovery – but not necessarily increased recycling, because incineration is currently the easiest and most widely used option.

The Commission has already taken some steps to aid the better implementation of waste legislation in MS[133], in particular with regard to the Landfill Directive. For example:

[132] EEA, 2010, Material resources and waste — SOER 2010 thematic assessment

[133] EC, 2011, Commission staff working document accompanying the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the Thematic Strategy on the Prevention and Recycling of Waste

- Awareness-raising events on the application of community legislation on shipments of waste, on landfills, on waste management plans and on waste prevention programmes were also organised by the Commission.
- Financial support has been made available for MS through Cohesion Policy[134] to improve waste management systems. The total support for waste management policies for the period 2000-2006 amounted to around €4.1 billion of which €1.5 billion from European Fund for Regional Development (ERDF) and €2.6 billion from the Cohesion Fund[135]. Projects funded under ERDF have led to the closure or rehabilitation of 964 unauthorised landfills (mainly in Spain and Greece) and the creation of new treatment capacity of 231,649 m³ per day in Spain and Hungary).

It is also important to note that, in order for the Landfill Directive to contribute more efficiently to recycling, current market failures in the recycling industry need to be addressed (capacity for recycling, demand for recycled materials).

The current capacities for waste incineration also have to be taken into account: some MS have developed significant waste incineration infrastructure to be able to treat increasing volumes of waste (e.g. France) and have therefore some incentives to use such infrastructure at full capacity rather than promoting more recycling[136].

Besides, the Landfill Directive focuses in particular on diverting categories of waste from landfilling which are biodegradable and/or hazardous. Less attention is being paid to categories of waste which have a potential high scrap value and which have a significant carbon footprint if they are not properly sorted and recycled. During the stakeholder consultation, it was highlighted that, for example, metals such as steel and aluminium no longer end up in landfills, as they constitute essential production materials that can easily be recycled, thus replacing primary metal that is increasingly imported[137]. This also concerns bottom ashes from the incineration of household waste, which contain valuable ferrous and non-ferrous metallic particles[138]. Although collection and recycling rates for used metal packaging are typically in the range of 60-70% across Europe, a considerable part is still not separated at the point of collection and runs the risk of being landfilled.

In order to divert from waste from landfilling and promoting its recycling, some stakeholders also recommended that up-to-date treatment facilities using the latest innovative sorting technologies[139] to be installed at local collection centres and, if and when appropriate, also at landfill sites.

[134] Council Regulation (EC) No 1084/2006 of 11 July 2006 establishing a Cohesion Fund
[135] DG REGIO estimations and DG REGIO study on the ex-post evaluation of Cohesion Policy Programmes 2000-2006
[136] In France, however, a recent Decree establishes limits to the capacities of incineration and landfilling facilities, at the department level (max. 60% of collected non-hazardous waste going to such facilities).
[137] This comment is in line with the objectives of the EU Flagship Initiative on Resource Efficiency under the Europe 2020 Strategy (COM(2011)21final) and the EU Initiative on Raw Materials.
[138] Waste incinerators typically produce about 20-25% bottom ashes from burning household waste. The bottom ashes would need to be "demetalised" in order to be fit for usage as raw material for road construction or other purposes.
[139] Recent sorting technologies are able to sort even the smallest metal fraction of up to a few millimetres.

4.2.2 Enforcement of Waste Shipment Regulation (WSR)

Influence of WSR on recycling

The WSR regulates the shipment of waste between MS and to third countries and sets the requirements at EU level for management and shipments of wastes. It sets up many rules including the following:

- Waste shipments have to be correctly labelled, depending on the category they fall into: the "green list" procedure applies to non-hazardous waste intended for recovery; the "notification procedure" applies to shipments of all waste intended for disposal and hazardous waste intended for recovery.
- Exports to third countries of waste intended for disposal are prohibited, except to European Free Trade Association (EFTA) countries that are party to the Basel Convention.
- Exports of hazardous waste intended for recovery are prohibited, except those directed to countries to which the OECD decision applies.
- Imports from third countries of waste intended for disposal or recovery are prohibited, with the exception of imports from countries to which the OECD Decision applies, third countries party to the Basel Convention, countries that have concluded a bilateral agreement with the Community or MS, or other areas during situations of crisis.

Whatever the procedure, all persons involved in shipment must ensure that they take all necessary measures in order that waste is managed in an environmentally sound manner throughout the shipment process and when it is recovered or disposed of.

Rules set up in the WSR are of primary importance to set the basis for a resource efficient society characterised by a high rate of recycling, avoiding a loss of materials which could be recycled within the EU.

Implementation status

More than one on four shipments of waste is currently found to be illegal[140], although this estimate is based on very rough data. Statistics reveal that the number of reported illegal shipments has increased between 2001 and 2005, considering that reported cases only represent a fraction of the real number of illegal shipments.[141] Illegal shipments are mostly composed of WEEE, ELV and plastics, which are materials that can be recycled, recovered or reused, providing that they are adequately sorted and depolluted.

The WSR is one piece of legislation that would clearly benefit from better implementation and enforcement.[142] It is the responsibility of each MS to implement the requirements of the WSR. The lack of precise instructions regarding inspections results in differing interpretations and

[140] K. Fras, European Commission (DG ENV), 2009, Challenges of resource efficiency
[141] EEA, 2009, Transboundary Shipment of Waste - Waste without borders in the EU?, report n° 1/2009
[142] The "Study on the feasibility of the establishment of a Waste Implementation Agency" reports that the waste shipments are "one of the most important areas of waste legislation where greater enforcement is needed".

uneven implementation across MS. Furthermore, confusion appears to exist between provisions in the WFD and the WSR in some MS in relation to the last owner of a product determining whether or not an object is waste. MS authorities desiring to avoid potential waste shipment may declare re-sold vehicles as waste, despite being sold and hence considered by the last owner as a usable product. Such an application of the WSR may restrict re-use and potentially go counter to the waste hierarchy.

Some of the issues faced during waste shipment inspections are briefly discussed here[143]:

- Resources and enforcement staff devoted by MS governments to waste shipment inspectorates are generally too limited to allow inspections to be run properly[144]. In addition, certain MS are more involved in tackling the issue of waste shipments than others, due to geographical location, size and number of ports, specific waste streams, waste routes, and political agendas. This results in an inconsistent enforcement of WSR throughout the EU. During the stakeholder consultation, it was highlighted that effectively implementing the Waste Shipment Regulation can sometimes result in prohibitively high costs, due to high administrative complexity, which can serve as a barrier to effective implementation of the waste hierarchy.
- Certain complex waste shipment types pose difficulties regarding their classification as waste, second hand material, by-products, or other. This is the case for used EEE vs. WEEE and used cars vs. ELVs for instance, where it can be difficult to prove whether the shipment is legal or not. This problem is emphasised by the fact that inspectors involved in verifying shipments are not always experts in waste or inspections of waste. The most recent version of the WEEE Recast (14 March 2011) provides minimum requirements for shipments of used EEE suspected to be WEEE, in Annex 1C; stakeholders highlighted that this may be a clause which could be extended across the other waste stream Directives.
- The implementation of WSR generally lies with many authorities e.g. environmental inspectorate, customs and police, which makes their cooperation crucial to ensure that inspections are performed efficiently. Nevertheless, currently the cooperation between different authorities is not sufficient in most MS.
- The efficiency of waste shipment inspections depends also on the strategy set up by national authorities. The lack of a common definitions and framework for the inspection strategy results in significant differences in interpretation and therefore entails variations in the way MS undertake inspections in practice.
- Difficulties arising relative to waste shipment inspections are also linked to waste shipments' multi-national aspect. Indeed, shipments originating in certain countries are transferred through other countries before reaching their final destination. A common level of implementation of the WSR is therefore needed to avoid an uneven distribution of risks and costs. If controls are not well performed at an early stage, it creates a burden for

[143] BIO Intelligence Service, 2010, Environmental, social and economic impact assessment of possible requirements and criteria for waste shipment inspections, controls and on-the-spot cheks, for DG ENV (http://ec.europa.eu/environment/waste/shipments/pdf/FinalReport_ENV(10)370155.pdf)

[144] Milieu, AmbienDura and FFact (2009) Study on the feasibility of the establishment of a Waste Implementation Agency, Revised Final Report, page 43

countries performing inspections at a later stage, i.e. during the transit or at the destination point.

- Stakeholders mentioned the difficulty of assessing the quality of treatment for waste sent outside the EU and the difficulty of capturing not only waste treatment conditions and recycling quality, but also health and safety conditions of people working in waste treatment facilities. Stakeholders cited a lack of feeling of responsibility on behalf of MS for ensuring appropriate treatment outside of the EU-27 and a lack of established standards available for assessing treatment quality in other countries. Article 10 on Shipments of WEEE in the recast WEEE Directive specifies that "*The treatment operation may also be undertaken outside the respective Member State or the Community provided that the shipment of WEEE is in compliance with applicable Union legislation*"[145]. Annex 1C of the recast Directive provides minimum requirements for the shipments of used EEE suspected to be WEEE, including specifying extra documentation required, functionality testing to be undertaken, and information from testing to be recorded and displayed on the shipment. Such clauses could be a basis for better assessing the quality of treatment for waste sent outside of the EU.

Potential benefits from increased enforcement

For the four waste streams targeted by this study (packaging, ELVs, WEEE, batteries), better enforcement of the WSR would probably increase the collection rates, by preventing illegal shipments of recyclable waste. However, it is difficult to estimate the extent to which recycling could be increased in the absence of any reliable data.

More inspections are likely to lead to more illegal waste shipments being detected. This is expected to have two consequences. In the short-term, detected illegal shipments will have to send their waste to *ad hoc* treatment facilities within the EU, thus increasing waste volumes to be treated. In the medium-term, it is expected that inspections would have a deterrent effect and would result in less waste being illegally shipped. As a significant proportion of illegal waste shipments results from badly sorted waste, it can be expected that waste would be better sorted, leading to continued shipments of a large part of the waste (legally) outside the EU and treatment of the remaining part within the EU. Thus, the activity of the waste sector could become more specialised in the EU towards sorting and/or treating specific types of waste.

Several initiatives as the programmes by IMPEL-TFS and the enforcement actions in MS are already in place to improve the situation. The IMPEL Threat Assessment report[146] underlined the fact that overwhelmingly, MS want more support for enforcement at an EU level, including training and standardisation in the interpretation of legislation. Additionally, an impact assessment of several implementing criteria for waste inspections was carried out in 2010[147] in

[145] EC, 2011, Proposal for a Directive of the European Parliament and of the Council on WEEE – (recast) – Political agreement (http://register.consilium.europa.eu/pdf/en/11/st07/st07851.en11.pdf)

[146] Environment Agency England and Wales, Jill Dando Institute of Crime Science, University College London (2006) IMPEL-TFS Threat Assessment Project: The illegal shipment of waste among IMPEL Member States

[147] BIO Intelligence Service, 2010, Environmental, social and economic impact assessment of possible requirements and criteria for waste shipment inspections, controls and on-the-spot checks, Report for DG ENV

order to analyse their possible inclusion in a legislative instrument at EU level, either as a Directive or as a Regulation. Examples of criteria assessed in this study are as follows:

- Effective capacity of competent authorities for waste shipment enforcement
- Effective inspection strategy
- Risk profiling and risk assessment
- Waste shipment inspection planning
- Waste shipment inspection programme and sampling plan
- Quality of laboratory facilities
- Competence of inspectorate staff
- Training of staff
- Cooperation between competent authorities.

The Commission has already taken some steps to aid the better implementation of waste legislation in MS[148], in particular with regard to the WSR. For example:

- Information exchange and awareness-raising events have been held on WSR
- Joint enforcement and inspection actions have been carried out in cooperation with the IMPEL Network and a study was undertaken on the case for developing European level legislation on the criteria and standards of shipment inspections.[147]
- A stakeholder consultation was held on possible EU legislative criteria and requirements for waste shipment inspections (carried out 25 January 2011 to 12 April 2011). It indicated that that there was scope for further improving co-ordination of waste shipment enforcement activities at EU level and that there was a need for guidance to customs to facilitate the identification and differentiation of used goods and waste.[149]

As for the Landfill Directive, in order for the WSR to contribute more efficiently to recycling, current market failures in the recycling industry need to be addressed in parallel to better enforcement of existing legislation.

[148] EC, 2011, Commission Staff Working Document accompanying the Communication from the Commission to the European Parliament, the Council, the European Economic and Social Committee and the Committee of the Regions on the Thematic Strategy on the Prevention and Recycling of Waste

[149] EC, 2011, Consultation on possible EU legislative criteria and requirements for waste shipment inspections (http://ec.europa.eu/environment/waste/shipments/pdf/stakeholder_consultation.pdf)

4.3 Flexibility and adaptability of waste stream Directives

It is essential to allow legislation to evolve in line with a changing context, technical and scientific progress, new practical needs, etc. Without the possibility of reviewing, legislation would be too rigid and would rapidly be disconnected from reality. The provisions for review can be of a different nature but it is important that they are adequately designed for the particular piece of legislation concerned.

Flexibility and adaptability relate to the ability of legislation to adapt rapidly to evolving knowledge and changing context without requiring substantial reviews on a too frequent basis.

This section assesses whether the current waste stream Directives are flexible enough to accommodate future evolutions that may have to be taken into account.

4.3.1 Overview of existing legal mechanisms

European legislation can be amended/modified/reviewed via two key routes at the EU level i.e. the comitology process and the ordinary legislative procedure.

Comitology

Comitology refers to the system of implementing committees that supervise the Commission in the execution of powers delegated to it in items of EU legislation. Changes undertaken under comitology are very specific in their nature and are generally related to technical aspects.

In July 1987, the Council adopted a 'Comitology Decision,' defining specific committee variants and procedures for the exercise of the implementing powers conferred on the Commission. The 1987 procedures were replaced by a June 1999 Comitology Decision[150]. Three types of committees - advisory, management and regulatory committees - work according to different procedures and have varying levels of legislative control over the Commission.

Since 2008, the ELV, WEEE, RoHS and Battery Directives have been subject to a specific procedure named "regulatory procedure with scrutiny" contained in Decision 2006/512/EC, which allows the legislator to oppose the adoption of draft measures where it indicates that the draft exceeds the implementing powers provided for in the basic instrument, or that the draft is incompatible with the aim or the content of that instrument or fails to respect the principles of subsidiary or proportionality.

This regulatory procedure with scrutiny met a longstanding request by the EU Parliament to improve its rights to monitor the implementation of legislative acts adopted under the codecision procedure[151]. This procedure was adopted to provide more power to the Council and

[150] Decision 1999/468/EC

[151] EC, 2009, the codecision procedure (art 251 TEU), Analysis and statistics of the 2004-2009 legislature, available at: ec.europa.eu/codecision/statistics/docs/report_statistics_public_draft_en.pdf

the EU Parliament on sensitive elements, like for instance adding a substance to the annex of a Directive.

Since the entry into force of the Lisbon Treaty or Treaty of the Functioning of the European Union (TFEU) in 2009, the Comitology procedure has been replaced by a new system of "delegated acts"[152]. Limited powers to make minor changes to laws are delegated to the Commission, provided these do not affect the "core" legislation decided by the EU Parliament and the Council. The "delegated act" is defined in terms of its scope and consequences – as a general measure that supplements or amends non-essential elements[153]. It is defined at article 290 of the TFEU.

Under the system introduced by Article 290 TFEU, the Commission is no longer required to obtain an opinion from MS Committees. Instead, it must submit its proposed delegated acts for scrutiny directly and simultaneously to the EU Parliament and the Council. In practice, however, it is unlikely that committees will disappear, as in particular the MS, as members of the Council, will need to turn to experts to vet the Commission's proposal. Thus, in order to avoid opposition, it is likely that the Commission would consult with expert groups composed of MS representatives and national ministries and agencies, as well as Members of the EU Parliament and/or EU Parliament Committees before submitting proposed delegated acts[154].

It is likely that the changes made in the waste stream Directives as a consequence of the TFEU remain minor in this respect[155]. Besides, the "old" Comitology Decision will continue to apply to acts adopted before the TFEU's entry into force, as long as those acts are not amended. A full alignment is anticipated by 2014.

The Council and the EU Parliament now hold significant power since they can oppose measures on any ground. It might increase the number of oppositions, possibly emanating from the EU Parliament and increase the average duration of the procedure.

Ordinary legislative procedure

Legislation can be modified through the "codecision" procedure. This procedure was defined as the main legislation procedure by Lisbon Treaty and renamed "ordinary legislative procedure" (Art. 294 of the TFEU). This procedure, now applicable to more than 80 domains, puts the Council and Parliament in equal footing as regards the adoption of legislation. It involves several steps launched by a proposal from the Commission and followed, *inter alia*, by first and possible second readings of the Council and the EU Parliament and a procedure of conciliation in case no agreement is reached.

Reviews undertaken under the ordinary legislative procedure are more substantial than modifications under the comitology procedure and amend fundamental aspects of legislation.

[152] European Parliament, 2010, Legislating more efficiently: questions & answers on new delegated acts, available
[153] Regulation N° 182/2011 of 16 February 2011 laying down the rules and general principles concerning mechanisms for control by Member States of the Commission's exercise of implementing powers
[154] Covington and Burling LLP, 2011, E-Alert Government affairs, reform of the EU comitology procedure
[155] IEEP, 2009, Coherence of waste legislation – Assessment of lessons learnt from the EU "Recycling Directives", for DG ENV

However, the distinction between the comitology and the ordinary legislative procedure is not always clear and one could argue that the exemption procedure under RoHS has such impacts that it should be part of a review under the ordinary legislative procedure[155].

4.3.2 Evolution of the waste stream directives with existing legal mechanisms

The use of comitology to amend the waste stream Directives

Table 15 below provides an overview of the most common tasks undertaken under comitology for the waste stream Directives. It shows the categories of common activities set out in the mandate of the Directives and the number of occurrences within a given Directive of a task classified within the specified category. The dark grey cells indicate the activities that have actually taken place in comitology meetings.

Table 15 : Common tasks mandated and undertaken within comitology meetings[154]

Task category	ELV	WEEE	RoHS	Batteries	Packaging	Total
Labelling/ Marking/ Certificates/ Legislation	2	1		2	1	6
Exemptions/ substitutions	1		1	2	1	5
Reporting format	1	1		1	1	4
Review/compliance	1	1	1			3
Treatment process	1	2				3
Concentration limits/ criteria	1		1		1	3
Implementation Difficulties				1	1	2
Calculation Methodology				2		2
Scope		1				1
Recycling				1		1
Exports				1		1

A previous study concluded that the scope of tasks covered by the comitology procedure seems to be well accepted by stakeholders and that there was a consensus that such tasks are suitable for attention and decision making under the comitology procedure[155]. The only criticism raised

concerned RoHS exemptions being part of the comitology procedure, which led to a legal case between the Commission and the EU Parliament before the European Court of Justice[156].

The existing system and its scope seem to have been suitable for the types of technical evolutions required by the waste stream Directives.

Amending legislation

European Directives can contain clauses that plan for their revision:

- Review clauses: provide that the functioning of a legislative act will be examined at a set date
- Revision clauses: stipulate that a legislative act will have to be amended by a set date without necessarily defining the nature of that amendment
- Sunset clauses: indicate that the legislative act will only be valid for a specified period of time.

Legislation generally contains review clauses planning the review of certain provisions to help prevent the text from becoming obsolete. Review is of particular importance for waste stream Directives since technical and scientific knowledge evolves at a high pace in the area of waste management[157]. Normally, amendments take the form of new pieces of legislation called "amending directives" which undergo the ordinary legislative procedure. The changes brought are then added to the original text by means of codification.

Examples of review underwent by the waste streams Directives include the following:

- The Packaging Directive was reviewed in 2004 in order to change definitions and adjust targets for recycling and recovery
- ELV, WEEE, RoHS and Batteries Directives were amended in 2008 in order to refer to the new Comitology regulatory procedure with scrutiny.

The waste stream Directives all contain review provisions being either specific review clauses or other articles providing for the review of specific provisions of the Directive (see the table below).

Table 16: Revision clauses in the waste stream Directives

Directives	Review clauses	Other types of clauses
ELV	No specific review clauses	Provisions on review included in other articles
Packaging	No specific review clauses	Provisions on review included in other articles
RoHS	Articles entitled "Review"	
WEEE	No review clauses as such	A clause entitled "adaptation to scientific and technical progress" being in essence a review clause
Waste Framework Directive	Clauses entitled "Reporting and reviewing" and "Interpretation and adaptation to technical progress"	

[156] European Court of Justice, European Parliament vs. Commission, joint cases C-14/06 and C-295/06
[157] Europa website, better regulation (http://ec.europa.eu/governance/better_regulation/instruments_en.htm#_clauses)

The system could have been more effective if articles specifically dedicated to the review were clearly identified as such in each waste stream Directive by being separated from other provisions[158]. Setting up an adequate time scale and making provisions as clear as possible are also key requirements to ensure an adequate functioning.

Recasting legislation

To catch up with changing needs and circumstances and to attain new objectives, some laws are subject to frequent amendment. Normally, such amendments take the form of new laws. In certain cases these new laws, instead of simply modifying the parts of the law that need to be changed, present the required amendments into a consolidated text together with all past amendments[159]. This technique is called recasting; it is a form of simplification[160]. Recasting can be considered only for those Commission legislative initiatives that aim to amend existing legislation, on average 40% of the total number of Commission proposals in a year.

Unlike codification, recasting involves substantial changes, as amendments are made to the original act during preparation of the recast text[161]. It also gives a comprehensive overview of an area of legislation. The new legal instrument undergoes the full legislative process, repeals all the acts being recast and is published in the Official Journal[162].

The average time for a proposal to be adopted in co-decision can reach 18 months (excluding conciliation) depending on how significant the changes brought are and the extent of their impacts.

Two waste streams Directives are currently undergoing recast. Both proposals for a new WEEE Directive and for a new RoHS Directive have been proposed by the Commission on the 3 October 2008[163] and are still going through the legislative process, the recast RoHS Directive has been formally adopted[164].

4.3.3 Addressing future evolutions

This section analyses how recent and future evolutions could be integrated into the waste stream Directives. It also describes which possible options could be used to improve flexibility and adaptability of legislation.

[158] IEEP and Ecologic, 2009, Coherence of waste legislation – Assessment of lessons learnt from the EU "Recycling Directives"
[159] Europa website, codification and recasting (http://ec.europa.eu/governance/better_regulation/codif_recast_en.htm)
[160] Europa website, better regulation, available at: http://ec.europa.eu/governance/better_regulation/glossary_en.htm
[161] Europa website, Recasting (http://ec.europa.eu/dgs/legal_service/recasting_en.htm)
[162] Europa website, synthèse de la legislation (http://europa.eu/legislation_summaries/glossary/legislation_recasting_en.htm)
[163] Legislative observatory of the European Parliament, Waste electrical and electronic equipment WEEE (repeal. Directive 2002/96/EC). Recast (http://www.europarl.europa.eu/oeil/file.jsp?id=5723502)
[164] Directive 2011/65/EC of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment entered into force on 21 July 2011 and repeals Directive 2002/95/EC

Adequacy of the current legislation to address changes

Technical evolutions

Examples of technical evolutions that are likely to occur in the future include:

- Larger scope of end-of-life products, materials or components to consider
- New types of waste streams or waste materials
- Higher proven environmental impacts of waste
- Availability of advanced recycling technologies.

Until now, these types of modifications have been mostly addressed through comitology, as explained in the previous section. Comitology is a rapid process that allows the Commission to adopt technical changes to existing legislation without having to go through the whole legislative process. It seems to be well adapted to these types of technical evolutions, although the comitology procedure is likely to last longer due to modifications brought by the TFEU.

Waste hierarchy

In 2008, the WFD introduced the obligation to take into account the waste hierarchy and life-cycle thinking. The waste streams Directives do not necessarily adopt the same approach because they were adopted before the WFD, nevertheless it seems essential to integrate this waste hierarchy into the Directives (see Section 2.2.1). This might require substantial changes since the Directives are not harmonised in terms of priorities, objectives and terminology used.

Implementing the waste hierarchy in the waste stream Directives might entail other legislative changes that would have to be addressed at the EU or at the MS level, such as for instance:

- The waste hierarchy identifies re-use, preparation for re-use and recycling as priorities over energy recovery and disposal. It may require changes in the way products are designed and manufactured in order to allow their reuse and recycling. This may require additional provisions on ecodesign in the waste stream Directives.
- Since one essential pre-requisite for maximising reuse and recycling is the separation of wastes into reusable/recycle and non-reusable/non-recyclable materials as early in the process as possible, preferably by the original waste producer[165], some additional requirements on separate collection may have to be added to existing legislation.

However, there is some flexibility in the application of the waste hierarchy and the WFD allows diversions from this hierarchy in some cases: "when applying the waste hierarchy, MS shall take measures to encourage the options that deliver the best overall environmental outcome. This may require specific waste streams departing from the hierarchy where this is justified by life-cycle thinking on the overall impacts of the generation and management of such waste". This statement provides some flexibility and makes rules adaptable to different types of waste on a

[165]Waste Watch, 2010, Waste Watch response to the consultation on the review of waste policies (www.wastewatch.org.uk/data/files/resources/10/Waste-Watch-response-to-the-Waste-Policy-Review.pdf)

case-by-case basis. As an illustration, the European Federation of the Corrugated Board Manufacturers claims that "for many applications recyclable packaging reduces environmental impact more effectively than re-use"[166].

These possible diversions from the waste hierarchy have to be assessed and validated by MS on the basis of life-cycle parameters. As an example, a paper summarising the current evidence on how the waste hierarchy applies, seen through the prism of life-cycle thinking, has been published in the UK[167]:

- **Tyres:** recovery through the use in road services is better than energy recovery through cement kilns and pyrolysis and other methods of recovery
- **Lower grade wood:** energy recovery options are more suitable than recycling
- **Food and garden waste:** anaerobic digestion is better than other recycling and recovery options.

However, these diversion possibilities would not affect the waste streams Directives per se since flexibility here will occur at the MS level on a case-by-case basis.

Resource efficiency and life-cycle thinking

Resource efficiency and life-cycle thinking are key to an effective waste management. Article (2) of the WFD mentions the general objective of "moving towards a European recycling society with a high level of resource efficiency." Life-cycle thinking also underlies the waste hierarchy set up by the WFD.

The fundamental aim of life-cycle thinking is to reduce overall impacts of a product or a service taking into account all the impacts (environmental, economic and social) that a product or service will have throughout its life cycle, from cradle to grave[168]. This can involve trade-offs between impacts at different stages of the life cycle. As reducing the environmental impact of a product at the production stage may lead to a greater environmental impact further down the line, care needs to be taken to avoid shifting problems from one stage to another. An apparent benefit of a waste management option can therefore be cancelled out if not thoroughly evaluated.[169]

Life-cycle thinking is a key to achieve resource efficiency defined by the UNEP as "reducing the environmental impact of the consumption and production of goods and services over their full life-cycle in focusing on more outputs with fewer impacts (fewer resources, less pollution, fewer impacts on the conditions of poor people)".[170]

[166] FEFCO, no date, environmental benefits of recycling versus reuse, corrugated board packaging as an illustration (www.fefco.org/fileadmin/fefco_files/Publications/Other_Publications/aTriptique-03.pdf)
[167] UK Department of Environment and The Chartered Institution of Wastes Management, 2010, Stakeholder consultation on the revised WFD (http://www.defra.gov.uk/publications/2011/06/15/pb13529-waste-hierarchy-summary/)
[168] CIRAIG, no date, Life cycle thinking (http://www.ciraig.org/en/pensee_e.html)
[169] European Commission, no date, Life Cycle Thinking and Assessment for waste management (http://lct.jrc.ec.europa.eu/pdf-directory/Making-Sust-Consumption.pdf)
[170] Angela CROPPER, Deputy Executive Director UNEP, Decoupling economic growth from environmental degradation – the crucial role of resource efficiency

It appears that adaptability and flexibility of the waste stream Directives to take into account the concepts of resource efficiency and life-cycle thinking are limited. The waste stream Directives were developed between 1994 and 2006 on the basis of differing views and conceptions, therefore bringing such changes might require a recast of legislation since they are linked to the nature itself of the Directives. Changes would be required in terms of the objectives and principles stated and the terminology.

4.3.4 Possible improvements

Technical evolutions

In areas subject to continuous technical progress, very detailed legislation is required to frame the activities of actors involved, but it has limits. Developing very technical and detailed pieces of legislation makes them hard to understand and to implement. If very detailed texts were developed, they would need frequent updates to adapt to technical changes and this would result in financial burden for public authorities.

Although comitology seems to be well adapted overall to deal with technical evolutions related to the waste stream Directives, several stakeholders expressed their support for an increased use of standards and norms to simplify the implementation of legislation. Differing views were expressed as to whether standards should be made mandatory or whether they should remain voluntary, providing benchmarks and highlighting best practices. However, other stakeholders were strongly opposed to the use of standards, considered as not being developed in an independent and democratic way.

A standard/norm is a reference document based on a consensus and approved by a recognised organism that provides rules, guidelines or characteristics linked to activities or their results. Norms are generally based on the acquis of science, technique and experience and target the optimal well-being of the community. Norms correspond to the state-of-the-art at a given time[171].

Legislation referring to norms has several advantages[171]:

- It simplifies the content of legislative texts; legislation is made more stable, more focused on objectives and easier to read
- It makes the process of revision/update lighter since only the norms have to be adapted without any necessary change to the actual piece of legislation
- It eases or lightens controls which have to be performed by public authorities; norms can also constitute an advantageous system of evidence (i.e. a product complying with a norm is presumed compliant)
- It helps implement public policies or comply with international agreements

[171] French ministry of economy, industry and employment, 2009, Guide on the good use of norms in legislation (www.industrie.gouv.fr/portail/pratique/guide_juin09.pdf)

- It favours the spreading out of technical developments and competition between companies, while being an asset to access the international market
- As actors affected by the norm should have been involved in the norm development process, the implementation of legislation is made easier.

As stressed by the German institute of normalisation, standards play a major deregulatory role, relieving the state of the responsibility for developing detailed technical specifications. By referring to standards, legislation is more flexible in adapting to technical advances[172].

Examples of voluntary standards which have been successfully used for the WEEE waste stream include for example the standardisation of reporting and downstream monitoring (WEEE Forum Reporting Tool "WF_RepTool"), the standardisation of operators' processes (WEEELABEX) or the standardisation of 'recyclability' (IEC)[173].

However, referring to norms in legislation must be limited to specific cases since it also has significant flaws. Norms and standards are defined based on consensus between several actors and this consensus can involve a variable number of actors with differing interests. There are no safeguards preventing norms from reflecting certain points of view rather than others, that is why the democratic and independent process of law making should be favoured, while the use of norms should be limited to very technical areas where they bring added value. Another potential disadvantage with the use of norms and standards would be in terms of accessibility for SMEs, since access to such norms typically involves some type of payment. Additionally, issuing rules by using the ordinary law making process gives them legitimacy and acceptability, which it not true with norms and standards. Besides, one of the roles of legislation can be to inflect behaviours towards chosen objectives for the sake of general interest in order to improve the existing context, whereas standards simply reflect the state-of-the-art at a given time.

Conceptual changes

In order to facilitate subsequent legislative reviews and to improve coherence and readability of legislation, a possibility would be for the waste streams Directives to refer the WFD for all the aspects that are common to all of them such as definitions, waste hierarchy, producer responsibility, end-of-waste criteria, etc. While some Directives already refer back to the WFD for basic definitions such as "waste", aligning varying definitions of terms such as "producer responsibility" is crucial. In this situation, only specific requirements would remain in the waste stream Directives, while the aspects common to all the Directives would be contained in a unique core piece of legislation. Such a modification would involve amending the WFD and harmonising the legal bases of the waste stream Directives so that they all include environmental objectives (referring to Art. 175 of the former Treaty[174]) in addition to possible internal market objectives (referring to Art. 95 of the Treaty[175]).

[172] Deutsches Institut für Normung, no date, Success with standards (www.din.de/cmd?level=tpl-bereich&menuid=47563&cmsareaid=47563&languageid=en)
[173] Further details available at http://www.weee-forum.org/

[174] Art. 192 of the TFEU

[175] Art. 114 of the TFEU

Another key question to be further investigated concerns the stage(s) at which waste impacts should be regulated. A reflection should be conducted on whether end-of-life impacts should be better covered by EU ecodesign legislation or whether ecodesign requirements should be strengthened in existing waste stream Directives, or whether both options should be combined. Life-cycle analysis (LCA) can serve as a tool for guiding such decisions; while not a policy, it can help show the larger picture and avoid shifting impacts along the life-cycle instead of truly removing or reducing them; an EC JRC project on LCAs seeks to build a European and global database to ensure that all parties have access to the same data when completing a LCA.[176]

4.4 The example of nanomaterials

Nanomaterials are a particular example of new types of materials that can be found in waste in increasing quantities and raise questions with regard to their environmental and health impacts. Such materials are an example of a new set of risks and challenges to which EU waste policy may need to adapt in the future. Risks related to nanomaterials are a relatively recent area of research and are not yet subject to any guidelines or legislation at EU level; however, adaptation of EU waste policy might be required in the future to take into account possible new risks identified. This section analyses the issues raised by this new type of materials and how they could be addressed by future EU waste policy.

4.4.1 Definitions

Nanotechnology is defined as the field of science or engineering that can manipulate materials and fabricate devices at the atomic and molecular scale, called nanomaterials (see the box below).

Box 5: Terminology

- **Nanotechnology** is the engineering of functional systems at the molecular scale.
- **Nanoparticles** are particles that range between 1 and 100 nanometres (1 nm = 10^{-9} metre) or that have an aerodynamic diameter[177] of between 1 and 100 nm.
- **Nanomaterials** are materials in which one or more properties are determined to a significant degree by the presence of nanoscale structural features.

In nanomaterials, manipulations of the size and shape of structures, devices, and systems, produce new structures, devices, and systems with at least one novel/superior characteristic or property from those expressed at larger scales. One of the difficulties with defining nanomaterials and resulting nanowaste is their possibility to change forms and properties,

[176] EC JRC, 2010, ELCD core database version II (http://lct.jrc.ec.europa.eu/assessment/data)

[177] In general, a particle has an irregular shape and a proper density. The aerodynamic diameter is the diameter of a potential spherical particle having a density of 1 g/cm3 and the same sedimentation velocity as the particle studied. This aerodynamic diameter is used to quantify the size of an air particle.

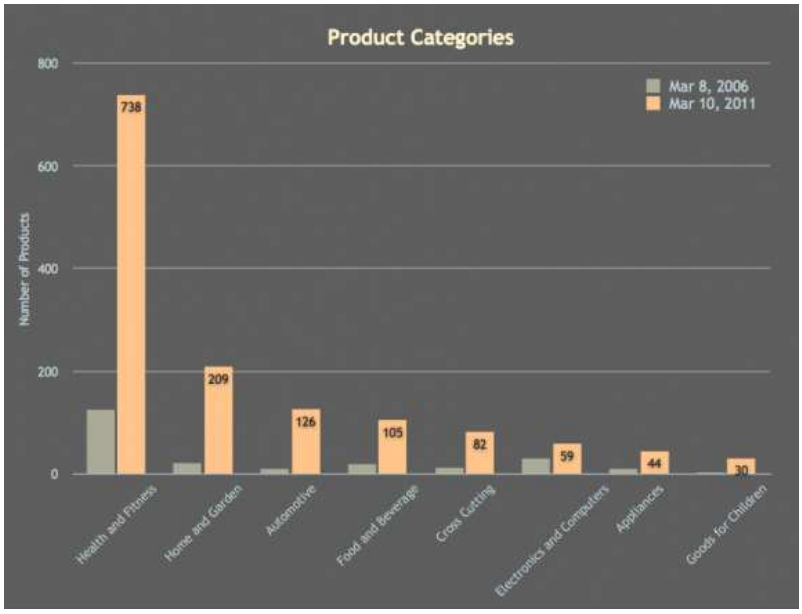
meaning that at end-of-life nanomaterials may no longer be found in products that initially contained nanomaterials.

Currently a definition is being developed by the European Commission, which should be released late summer 2011. In 2010, JRC released a report on considerations that should be taken into account when preparing a regulatory definition for nanomaterials. Their study suggests that such a definition should only concern particulate nanomaterials, be broadly applicable in EU legislation and align with other worldwide definition approaches in using size as the only defining property.[178]

4.4.2 Examples of products containing nanomaterials

Many industries use nanoparticles in their products (Figure 13), including in electronic equipment (Box 6) to reduce the size of components, in car accessories (to provide additional properties e.g. self cleaning tyres, anti-glare windows, stain resistant textiles, etc.), in coatings and in packaging to modulate the properties of materials[179].

Figure 13: Example of product categories containing nanomaterials[187]



In packaging manufacture, nanoparticles are for example used in PET bottles, to improve the protection of bottles against oxidative agents or to modulate the strength or rigidity of materials[180]. The packaging industry is also interested in materials in which nanoparticles could

[178] JRC, 2010, Considerations on a definition of nanomaterial for regulatory purposes (http://ec.europa.eu/dgs/jrc/downloads/jrc_reference_report_201007_nanomaterials.pdf)
[179] Brief overview of introductory materials on nanotechnology; applications of manufactured nanomaterials, the science, and coordination at the international level (Agenda item 4). Georg Karlaganis, UNITAR, 2010.
[180] Centre for Technology Assessment. Dinner is served! Nanotechnology in the kitchen and in the shopping basket – Abstract of the TA-SWISS study "Nanotechnology in the food sector". 2009 (www.ta-swiss.ch/a/nano_nafo/KF_Nano_im_Lebensmittelbereich.pdf)

be used as sensors (e.g. films changing colour according to the degree of ripeness, packaging with nanosensors to detect food spoilage[181,182]).

Box 6: Nanomaterials in electronics

The exceptional electrical, mechanical, optical, chemical, and thermal properties of thin, nanofilms make them especially attractive for novel multipurpose/multifunctional systems, where several of these unique properties combine to enable functionalities that are difficult or impossible to achieve with established materials and which could also permit to reduce the size of electronic materials.

Other specific properties such as the quantum effect or complexity are also used in commercialised consumer products. For example, in the microelectronic industry, the use of nanotechnology to miniaturise the circuit's elements in order to obtain increasingly complex systems has been largely applied. Carbon nanotubes, for instance, have been used for nanoscale transistors with a performance equal to or greater than that of traditional materials[183].

4.4.3 Nanomaterials in recycling processes and associated issues

Nanomaterials in the waste stream

Nanomaterials can be found in waste in increasing quantities, as there are increasing volumes of nanoproducts placed on the market (Figure 14). This could result in a number of potential environmental and health issues.

On the other hand, nanomaterials can be used to prevent and remove various forms of environmental pollution[184]; however, this second aspect is outside the scope of this study.

Nanomaterials that could be present in the waste stream – and thus could be carried along the recycling process – include[185]:

- Pure manufactured nanomaterials (e.g. carbon nanotubes)
- Nano byproducts
- Liquid suspensions containing nanomaterials
- Items contaminated with nanomaterials (e.g. wipes)
- Solid matrices with integrated nanomaterials.

[181] Busch L. Nanotechnologies, food, and agriculture: next big thing or flash in the pan? Agric Hum Values. 2008;25:215–218

[182] Sozer N., Kokini JL. Nanotechnology and its applications in the food sector. Trends Biotechnol. 2009;27(2):82-9

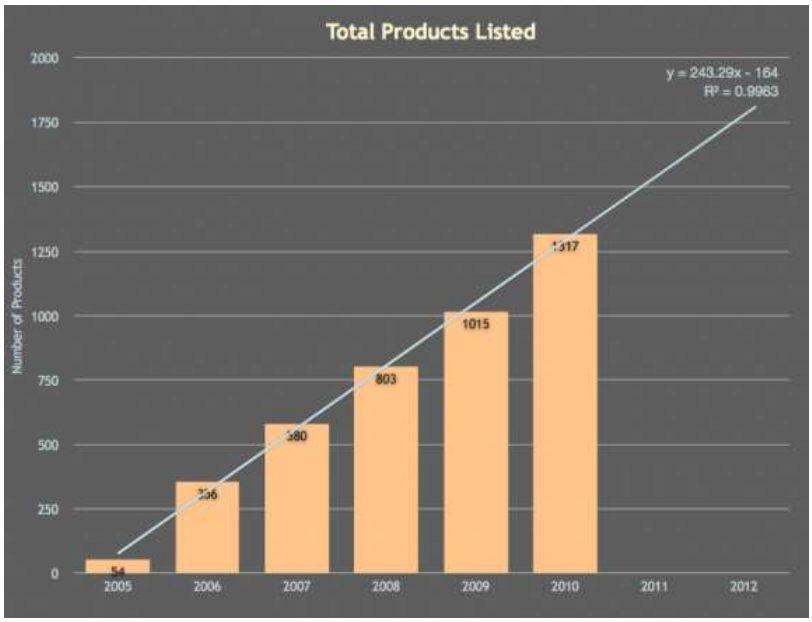
[183] DeHon D. Array-Based Architecture for FET-Based, Nanoscale Electronics. IEEE transactions on nanotechnology. 2(1):23-32, 2003.

[184] This is based on their ability to react with chemicals or contaminating microorganisms present in soil or water. For instance, in wastewater and groundwater treatment nanoparticles could be used to eliminate organic dyes, inorganic compounds (e.g. nitrates) and to treat refractory organic compounds. In addition, in sewage plants nanomaterials could avoid the propagation of nanoparticulate contamination emitted from consumer's products into the aquatic environment

[185] BSI PD 6699-2(2007): Guide to safe handling and disposal of manufactured nanomaterials

- When disposing of products that contain synthetic nanomaterials, hazardous nanoparticles may enter the environment or affect the recycling of composite materials and plastics. For this reason, the Swiss Action Plan on synthetic nanomaterials stated that there is a need to develop appropriate procedures for their disposal[186].

Figure 14: Number of total products listed in the PEN inventory[187]



Given the high value of specially manufactured nanomaterials (e.g. nanoscale metals), manufacturers and users may have a strong interest in recovering certain nanomaterials for reuse or recharge of products. However, due to a lack of information on nanomaterials they may be declared as or treated as hazardous waste, which could lead to a loss of valuable materials.

A number of technical solutions have been explored for recycling these categories of materials, as discussed in the following section.

Technical solutions for the recycling of nanomaterials

Several studies investigated the potential to separate nanoparticles from the waste stream in order to recycle them. The majority of the tested processes are conventional separation techniques, like centrifugation or solvent evaporation, with high energy demand. Alternative methods such as the application of magnetic fields, pH and thermoresponsive materials, molecular antisolvents, or nanostructured colloidal solvents provide effective and efficient methodologies for recycling nanoparticles without significant costs, time consumption, or energy demand[188].

[186] Swiss Action-plan "Synthetic Nanomaterials": Regulatory framework for the responsible handling of synthetic nanomaterials

[187] The PEN Nanotechnology Consumer Product Inventory finds that over 1,300 manufacturer-identified nanotechnology-enabled consumer products have entered the marketplace to date (Source: http://www.nanotechproject.org/inventories/consumer/analysis_draft)

[188] Recycling Functional Colloids and Nanoparticles (2010). Myakonkaya et al. Chemistry, a European journal.

However, in order to set up efficient recycling for nanomaterials, further studies on their intrinsic recyclability properties such as thermal, mechanical, and chemical properties are needed. Information on how these characteristics are changed once nanomaterials are mixed with other products is also needed, as well as guidelines regarding the take back, disassembling and reuse in such cases. A reflection on how a proper product design could improve the disassembling of these materials would also help identify appropriate reuse and recycling options.

Potential environmental and health issues

Life Cycle Assessment (LCAs) is used to evaluate the impacts of products on the environment throughout their entire life-cycle, from the extraction of resources to the end-of-life. For nanomaterial-containing products, this methodology is difficult to apply, due to the scarcity of environmental and toxicological data. To date, only a few LCAs have been performed for nanomaterial-containing products, and one can only talk about potential issues rather than quantified impacts of nanomaterials in the waste stream. Very recently, the International Organization for Standardisation published a specific standard (ISO/TR 13121:2011) for nanomaterials. The standard describes a process for identifying, evaluating, addressing, making decisions about, and communicating the potential risks of developing and using manufactured nanomaterials.

The information needed to evaluate the potential environmental and health issues related to nanomaterials' in the waste stream includes[189]:

- **Information on nanowaste volumes**: At present, estimates have only been developed on the basis of production data. As an example, for carbon-based nanomaterials, tens of thousands of tonnes per year have been estimated at the global level. Due to uncertainties on waste volumes, it is impossible to date to provide suggestions on management strategies. However, one possible action could be that producer companies fill in data sheets detailing nanomaterials production volumes in order to anticipate waste flows[190].
- **Fate, transport and behaviour of nanomaterials in the environment at their end-of-life:** Materials often behave differently in nanoform in comparison to how they would behave in bulk. For example, the larger surface area of nanomaterials means that they are likely to be more reactive with substances they come into contact with. Secondly, they may act as carriers for other pollutants, helping disperse them widely in the environment. Unknown behaviour of nanomaterials in waste treatment installations may thus influence the efficiency of recycling processes.
- **Information on nanomaterials' intrinsic toxicity (susceptibility from exposure)** to calculate safety and hazard factors for both nanomaterials and associated by-products in order to protect workers in the waste management sector (e.g. is there a need for specific protection measures and/or trainings for workers?)

[189] How to treat nanowaste. Presentation of M. Tellembach, terra Consult, Berne.
[190] Musee, N.,2011, Nanowastes and the environment: Potential new waste management paradigm. Environment International. 37: 112-128

- **Recyclability properties (see previous section) and behaviour in waste treatment facilities:** For instance, it is known that in wastewater treatment plants silver nanoparticles inhibit reproduction of bacteria that play a useful role (i.e. nitrifying bacteria that are essential to removing ammonia from wastewater treatment systems)[191]. Another aspect to consider is how to handle nanomaterials from incinerators. Some nanomaterials may not be decomposed upon incineration or captured in scrubbers, allowing their release into the air. According to a Swiss working group, the precautionary principle should be applied for the treatment in municipal waste incineration plants of nanowaste from production and processing[192].

4.4.4 Current policy context and possible policy actions

In a document dated November 2010[193], the European Commission stated that "*work towards a common definition on nanomaterials is still on-going and the Commission intends to adopt a Commission Recommendation on a common definition[194] for all legislative sectors in the near future".* While important, a definition will not be a panacea to solve all the issues related to nanomaterials as they are quite diverse and could involve different treatment options; understanding more about the various materials which could be contained in nanomaterials and nanowaste is crucial. JRC has established a repository of 25 different types of reference nanomaterials to support safety assessments and ensure consumer protection and confidence in a range of products and applications.[195] In addition to a lack of definition for nanomaterials at EU level, there is also a lack of specific references to the term "nano" in key environmental and waste legislation such as for example the WFD.[196] Such a lack of direct references makes it unclear if nanomaterials would even be captured under the WFD; furthermore, difficulties exist in terms of classifying some nanomaterials as hazardous as characteristics are not precisely known.

In the case of nanomaterials present in EEE, the Commission considers that "*the RoHS provisions cover different forms (including nanoforms) of the substances which are currently banned and those which will be in the future subject to a priority review under RoHS*"[193]. A number of industrial organisations are very concerned with proposals to regulate nanomaterials in the RoHS Directive recast[197]. They are especially concerned about proposals to take drastic measures such as restricting certain uses with immediate effect or introducing far-reaching notification and

[191] http://www.werf.org/AM/Template.cfm?Section=Home&TEMPLATE=/CM/ContentDisplay.cfm&CONTENTID=8272 [Accessed 8th June 2011]; while non nano silver has the same impact in inhibiting reproduction of bacteria, non nano silver is anticipated to less easily enter into waste water treatment plants due to its larger size.
[192] Document available at : http://www2.unitar.org/cwm/publications/event/Nano/Abidjan_25-26_Jan_10/16_How_to_treat_Nanowaste.pdf [Accessed 8th June 2011]
[193] Proposal for a Directive of the European Parliament and of the Council on the restriction of the use of certain hazardous substances in electrical and electronic equipment - (recast) – Outcome of the European Parliament's first reading (Strasbourg, 22 to 25 November 2010)
[194] The EC held a consultation on this document in 2010, a draft of the document is available here: http://ec.europa.eu/environment/consultations/pdf/recommendation_nano.pdf [Accessed 8 June 2011]
[195] Cosmetics & Toiletries, 2011, EC Establishes Nanomaterials repository (http://www.cosmeticsandtoiletries.com/regulatory/nanotech/116304684.html?page=1)
[196] Entec & Milieu, 2011, Review of environmental legislation for the regulatory control of nanomaterials, for DG ENV
[197] Directive 2011/65/EU of the European Parliament and of the Council of 8 June 2011 on the restriction of the use of certain hazardous substances in electrical and electronic equipment entered into force on 21 July 2011

labelling requirements, mainly because of a lack of systematic appraisal of the consequences of their implementation.

At present, Switzerland seems to be one of the most advanced countries with regard to the management of nanowaste. At the end of 2008, the Swiss Federal Office for Environment (FOEN) established a working group on nanowaste gathering all the involved stakeholders at the national level. The work of this entity is focused on nanowaste generated during nanomaterials production or transformation, which could in certain cases be considered as hazardous waste. Guidelines have been defined in this context, covering protection measures at the organisational and individual levels as well as elimination methods. As for nanowaste from products containing nanomaterials, the Swiss working group concluded that not enough information is currently available (see previous section).

In England and Wales, the Environmental Agency considers that unbound carbon nanotube waste containing >0.1% nanomaterials is hazardous waste, and therefore recommends that such waste is treated as such (high temperature incineration at a hazardous waste incinerator being the preferred disposal method).[198]

At this stage, it is therefore difficult to say how the possible environmental and health impacts associated with nanomaterials in the waste stream would be best addressed by EU waste legislation, and in EU products and chemicals policies more generally(since this issue is first of all a product-related issue). Priority should be given to the compilation of information on nanowaste flows, for example through the establishment of a list of nanoproducts manufacturers and importers and reporting requirements on quantities handled[199]. On the consumer side, specific labelling of nanomaterials could be set up (at least for those nanomaterials which keep their nano-size during the entire life-cycle), as well as product take-back requirements. In accordance with the pollution prevention principle, emissions of nanoparticles and rods should be minimised in order to decrease potential risks.

During the stakeholder consultation, it was highlighted that considering all waste containing nanomaterials as hazardous waste could be very detrimental to recycling. Therefore, clear dismantling requirements should be put in place as long as unknowns exist about nanomaterials, in order to separate them from other waste streams and therefore not jeopardise recycling policy. Provisions concerning easy dismantling of product parts containing nanomaterials could be included in product policy.

Reuse and recycling of nanowaste could be promoted or, alternatively, it could be required to destroy the "nano-character" (e.g. by acid dissolution of metals, high-temperature incineration of organic nanomaterials, sintering of ceramics or oxides) or to immobilise nanowaste in a specific containment[192]. It is also necessary to ensure that work undertaken in relation to nanowaste is joined up with similar work completed in the context of REACH.

[198] HSE, 2011, Risk management of carbon nanotubes (http://www.hse.gov.uk/pubns/web38.pdf)

[199] Such an effort is already ongoing with the launch of repository of nanomaterials by EC and JRC: http://www.cosmeticsandtoiletries.com/regulatory/nanotech/116304684.html?page=1

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Chapter 5: Conclusions and recommendations

Achievements of waste-stream Directives

Waste-stream Directives have provided significant environmental benefits, although higher benefits could be achieved by increasing collection and recycling and continuing efforts to divert waste from landfilling and incineration.

On the economic side, the waste streams Directives have enabled public authorities to reduce waste collection and treatment costs for the waste streams of concern. Compliance with producer responsibility requirements and other legislative requirements of the waste streams Directives have generated significant administrative costs for the private sector, although such costs are to some extent integrated in the price of products placed on the market. The implementation of the waste streams Directives has brought significant benefits to the waste recycling industry, through the establishment of minimum recycling targets.

With regard to social effects, information is not always available but it seems that overall the Directives have contributed to job creation: levels of material recycling have increased, leading to the development of new markets with associated jobs. Recycling creates more jobs than any other treatment option. In addition to jobs in the recycling sectors, new types of jobs have been created to monitor industry's compliance with product design requirements, in particular the RoHS requirements.

The overall implementation level of the Directives, at EU level, can be considered as medium. Recycling levels are rising across the MS; however, often at very different rates and from different baselines, depending on the MS considered. There is strong evidence that targets for recycling in the EU recycling acquis have driven significant improvements in levels of recycling across the EU. However, since 2004 evidence indicates performance has stabilised in several EU-15 MS. In the EU-12, recycling rates are more disparate.

Scope for coherence and harmonisation

Harmonising the waste stream Directives with the key concept introduced by the WFD would provide additional environmental benefits while reducing implementation costs for companies and MS. If the five waste stream Directives referred explicitly to a common set of core rules including common key definitions, a unique EPR scheme basis, and the waste hierarchy included in the WFD, this would likely result in reduced administrative burden for the implementation and transposition of possible new waste stream Directives and in more stringent requirements and a higher level of ambition. Integration of strengthened ecodesign requirements is also an important parameter that could improve the cost-effectiveness of the waste stream Directives.

However, it is important to note that there are limits to the level of harmonisation to be achieved in order to improve the efficiency of the waste stream Directives, as they cover different and very specific waste streams as well as have different legal bases. Besides, specific incoherence

between related pieces of legislation must be addressed in order to avoid issues such as legal uncertainty or double regulation. For instance, imprecise scope of certain Directives or unclear relations between different pieces of legislation has led to law breaches, market distortions and has generated additional costs for economic operators. Some of such inconsistencies were addressed by the recent recasts of WEEE and RoHS Directives.

In addition to improved coherence between the waste stream Directives and the WFD, an important issue to improve the cost-effectiveness is the consistency of transposition between MS. Indeed, significant costs and administrative burden for could result from inconsistencies in legal requirements across MS.

Drivers for resource efficiency

Some of the drivers identified by this study are already included in existing waste stream Directives but with varying ambition level:

- Drivers for recycling (e.g. through quantitative recycling targets) are well covered
- Drivers such as waste prevention or ecodesign are only mentioned in broad terms
- The waste hierarchy as defined by the WFD is not reflected in a consistent way across the waste stream Directives.
- The waste stream Directives lack consistency in terms of the approach used for to target setting and certain definitions (e.g. definitions related to EPR schemes, reuse)

Other drivers which could be integrated further in the waste stream Directives include:

- Provisions related to the quality of separate collection and recyclates
- Economic instruments
- Landfill bans or product bans targeted at single-use products generating significant environmental impacts

In terms of conceptual design of policy tools, the waste-stream approach and the material-based approach are complementary rather than mutually exclusive. For waste products with complex design and supply chain (e.g. WEEE), having specific legal instruments could be relevant as this allows to take into account a high number of technical parameters and ecodesign criteria. However, for other waste streams such as bio-waste, the adequacy of a separate legal instrument is questionable. The introduction of material-based targets, in addition to specific waste stream related provisions, could bring significant environmental benefits in the short term. However, replacing the current waste stream Directives and focusing only on a material-based approach does not seem to be a realistic.

Beyond the achievement of a good level of implementation of legal provisions recommendations with regard to the drivers for resource efficiency include:

- Harmonisation of the waste stream Directives with the WFD in the view of improving clarity and coherence among Directives
- Improving the measurement of the achievement of targets

- More emphasis to be placed on waste prevention and product design
- Encouraging the use of complementary tools such as economic instruments at MS level

Adding these new provisions seems necessary to promote resource efficiency and move towards a "recycling society". This study also illustrated some potential gaps in the EU waste legislation in terms of the coverage of waste streams. A comprehensive assessment of waste streams of greatest environmental concern, based on a quantification of life-cycle impacts and analysis of current waste management options, will provide a deeper insight to the possible approaches and integration of drivers for improved resource efficiency. However, further analysis would be required in order to assess whether such aspects would be more efficient if included in the waste stream Directives or if included in other pieces of legislation or through voluntary agreements or other policy tools at MS level.

Key challenges for future waste legislation

A broad range of obstacles and possible solutions are identified which could be taken into account in the future waste legislation. Following is a possible list of priority actions.

- Enforcement
  - Exploration of tools for increasing enforcement to ensure MS compliance
  - Better monitoring of MS waste management plans by the Commission to ensure appropriateness
  - Inspections on the compliance of recycled materials with regard to allowable levels of hazardous substances
- Awareness-raising and communication
  - Communication campaigns to encourage participation by consumers, including making consumers aware of the negative impacts
  - Measures to improve local authorities' awareness and understanding of the latest developments in sorting, separation and end-of-life options for waste streams
  - Encouraging sharing of best practices across MS

At the corollary acquis level, projections on the mid-term show that recycling is expected to increase, and could increase even more if the corollary acquis were better implemented or reinforced by additional policy instruments.

The Landfill Directive seems to have contributed to increased levels of recycling; however, countries where the diversion of waste from landfilling to recycling has been successful have generally been put in place additional policy measures such as measures going beyond the Directive's requirements. Nevertheless, increased enforcement of the Landfill Directive could lead to increased incineration – with or without energy recovery – but not necessarily increased recycling, because incineration is currently the easiest and most widely used option.

The WSR would clearly benefit from better implementation and enforcement. The lack of precise instructions regarding inspections results in differing interpretations and uneven implementation across MS. Furthermore, confusion appears to exist between provisions in the WFD and the WSR in some MS in relation to the last owner of a product determining whether or not an object is waste. For the four waste streams targeted by this study (packaging, ELVs, WEEE, batteries), better enforcement of the WSR would probably increase the collection rates, by preventing illegal shipments of recyclable waste. However, it is difficult to estimate the extent to which recycling could be increased in the absence of any reliable data.

Flexibility and adaptability of the waste stream Directives is key to ensure that current and future challenges be adequately addressed by waste legislation. Various legal instruments have allowed technical evolution to be adequately addressed until now. However, the integration of new concepts such as "resource efficiency" and "life cycle thinking" poses difficulty, and changes in the waste stream Directives might be required in the future.

Nanomaterial is an example of new types of materials that can be found in waste in increasing quantities and raise questions with regard to their environmental and health impacts. At this stage, it is difficult to say how potential environmental and health issues could be best addressed by EU waste legislation, and in EU products and chemicals policies more generally. Priority should be given to the compilation of information on nanowaste flows, for example through the establishment of a list of nanoproducts manufacturers and importers and reporting requirements on quantities handled, Such an effort is already ongoing with the launch of repository of nanomaterials by EC and JRC. On the consumer side, specific labelling of nanomaterials could be set up as well as product take-back requirements. In accordance with the pollution prevention principle, emissions of nanoparticles and rods should be minimised in order to decrease potential risks.

In order to set up efficient recycling for nanomaterials, further research on their recyclability properties is required. Information on how these characteristics are changed once nanomaterials are mixed with other products is also needed, as well as guidelines regarding the take back, disassembling and reuse in such cases. A reflection on how a proper product design could improve the disassembling of these materials would also help identify appropriate reuse and recycling options. Understanding more about the various materials that could be contained in nanomaterials and nanowaste is crucial.

Glossary

This glossary is based on the terminology used in the Waste Framework Directive 2008/98/EC.

- **bio-waste** means biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises and comparable waste from food processing plants;
- **waste producer** means anyone whose activities produce waste (original waste producer) or anyone who carries out pre-processing, mixing or other operations resulting in a change in the nature or composition of this waste;
- **waste management** means the collection, transport, recovery and disposal of waste, including the supervision of such operations and the after-care of disposal sites, and including actions taken as a dealer or broker;
- **collection** means the gathering of waste, including the preliminary sorting and preliminary storage of waste for the purposes of transport to a waste treatment facility;
- **separate collection** means the collection where a waste stream is kept separately by type and nature so as to facilitate a specific treatment;
- **prevention** means measures taken before a substance, material or product has become waste, that reduce:
  - the quantity of waste, including through the re-use of products or the extension of the life span of products;
  - the adverse impacts of the generated waste on the environment and human health; or
  - the content of harmful substances in materials and products;
- **reuse** means any operation by which products or components that are not waste are used again for the same purpose for which they were conceived;
- **treatment** means recovery or disposal operations, including preparation prior to recovery or disposal;
- **recovery** means any operation the principal result of which is waste serving a useful purpose by replacing other materials that would otherwise have been used to fulfil a particular function, or waste being prepared to fulfil that function, in the plant or in the wider economy. Annex II of the WFD sets out a non-exhaustive list of recovery operations.
- **preparing for re-use** means checking, cleaning or repairing recovery operations, by which products or components of products that have become waste are prepared so that they can be re-used without any other pre-processing;
- **recycling** means any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the

reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations;

- **disposal** means any operation that is not recovery even where the operation has as a secondary consequence the reclamation of substances or energy

Annex 1: Overview of recycling and resource efficiency drivers

Legislative text	Provisions on waste prevention	Provisions on design for recyclability	Recovery targets	Provisions on Extended Producer Responsibility (EPR)	Provisions on quality of separate collection and quality of recyclates	Economic instruments (other than EPR provisions)	Landfill bans or product bans
Batteries Directive (2006/66/EC)	Focus on recycling rather than prevention Public information campaigns on batteries and accumulators to be funded by battery producers	Not addressed	Specific rules for the collection, treatment, recycling and disposal of waste batteries and accumulators Binding targets on collection rate and recycling rate Places a ban on the final disposal of industrial and automotive batteries and accumulators in landfills or by incineration	Producer responsibility requirement included Take back obligations applied for distributers Battery producers to finance costs of collection, treatment and recycling of waste	Not addressed	Not addressed	Not addressed
Packaging Directive (94/62/EC)	Does not highlight the importance of waste prevention as a priority in the waste hierarchy	Not addressed in much detail	Requires MS to establish return, collection and recovery systems Binding targets for recovery and recycling	Responsibility falls to MS, not to producers Requires economic operators, including producers and suppliers of packaging materials, to provide reporting on packaging waste	Not addressed	Not addressed	Not addressed
End-of-Life Vehicles Directive (2000/53/EC)	Seeks to prevent waste from vehicles Bans the use of certain hazardous substances within materials and components used in vehicles	Only addressed in the recitals, in general terms	Controls the operations of those collecting and treating ELVs Binding targets for collection rate and for reuse, recycling and other recovery options	Producer responsibility requirement included Producers responsible for all or a significant part of the costs Definition of producer is less detailed than in WEEE/RoHS and Batteries	Not addressed	Not addressed	Not addressed

WEEE Directive (2002/96/EC) and RoHS Directive (2002/95/EC)	WEEE Dir.: Seeks to prevent the production of WEEE Encourages design and production of EEE to take account of future reuse via specific design features and manufacturing processes RoHS Dir.: Seeks to restrict the use of hazardous substances in EEE and their appearance on the market	WEEE Dir.: Encourages design and production of EEE to take account of recycling and recovery via specific design features and manufacturing processes	WEEE Dir.: Binding targets for collection rate, for reuse and for recycling (recast proposal)	WEEE Dir.: Producer responsibility requirement included Producers required to finance systems for the treatment of WEEE and distributers to take back products Includes clause in Article 8 on individual producer responsibility (i.e. for their own products) for new WEEE Allocation of responsibility for funding and set up of collection systems varies across MS and is assigned to either the distributer, municipality or producer	Not addressed	Not addressed	Not addressed
Legend:							
Green:	Driver included in the Directive						
Yellow:	Driver mentioned in the Directive but with limited/vague provisions						
Red:	Driver not integrated into the Directive						

Annex 2: Overview of current achievement level of recycling targets and potential benefits from full achievement

The table below provides a summary of information available on the level of achievement of recycling targets included in the waste stream Directives (on batteries, packaging , ELVs and WEEE) as well as a qualitative overview of environmental benefits resulting from the achievement of these targets (in the current state and in the case of full achievement).

Legislative text	Extent and quality of reporting on implementation	Overall level of achievement with regard to recycling targets	Environmental benefits	
			Current status	If targets fully achieved
Batteries Directive (2006/66/EC)	**Moderate** Limited existing reporting, first official reporting to the EC required as of 2013	Difficult to assess as official reporting is not yet available In 2008, collection rate was estimated at 18%; 7 MS had already met the 25% target as of 2008 (compliance deadline is 2012)	Limited information is yet available on the current implementations status, but significant material savings can be expected from the achievement of the collection target for 2016 and currently applicable recycling targets.	
Packaging Directive (94/62/EC)	**Moderate** One-third of MS did not reply on time; in many cases the replies were incomplete and the quality of reporting varied	**High** As of 2009, the directive had been properly transposed by all MS and the overall level of implementation was satisfactory As of 2008, 61% of packaging waste recycled As of 2002, all 75 different targets for the EU-15 had been achieved No infringement cases were open in 2009	**High benefits** Separate collection systems in place Environmental benefits achieved from stable recycling and recovery rates	**High benefits expected** Although minimal change from current resource efficiency is expected
End-of-Life Vehicles Directive (2000/53/EC)	**Low** As of the 2005-2008 reporting period, reporting discipline was not fully satisfactory and the timeliness of reporting was poor; five MS did not provide information concerning the incorporation of the directive into their national law; in 2009, 6 cases for non-reporting were still pending	**Low** In 2006, 19 MS met 80% reuse/recycling target; 13 MS met 85% reuse/recovery target In 2009, 9 non-conformity cases were still pending	**Moderate benefits** Promoted resource efficiency via innovation in vehicle design and treatment of ELVs Improved efficiency of the treatment sector (recyclability)	**High benefits expected** Achievement of environmental and economic benefits steaming from eco-innovation Current targets will necessitate the improvement of recycling and recovery of plastics from shredder residue Estimated environmental benefits include savings of between 280,000 and

Legislative text	Extent and quality of reporting on implementation	Overall level of achievement with regard to recycling targets	Environmental benefits	
			Current status	If targets fully achieved
				980,000 tonnes of CO_2 equivalent per year, reductions in photochemical oxidation, air acidification, water pollution and eutrophication and reductions in waste generated; actual environmental benefits are dependent on technological development the targets stimulate
WEEE Directive (2002/96/EC)	**Moderate** Approximately one-third of MS did not reply on time for 2006 reporting, However, reporting for 2008 was provided by nearly all MS. As of 2009, there was 1 infringement case for failure to report.	**High** Collection of rate of 4 kg/capita has been met by majority of MS; average collection rate for the EU-27 is 70%, average recycling rate as of 2008 totals to 76% and recovery rate totals to 81%.	**Moderate benefits** While collection, recovery and recycling/reuse rates have been increasing, gaps remain and confusion exists on the application of certain aspects of the Directive.	**High benefits expected (WEEE recast)** The Directive is about to be revised, with more stringent targets and requirements proposed. This is expected to address a number of problems identified in its implementation. The EC's impact assessment of a potential recast WEEE Directive estimated annual costs at 1€ billion, a figure evened out by a gain of environmental benefits of the same amount per year.

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Annex 3: Analysis of recycling targets

The table below provides a qualitative analysis of the desirability of more stringent recycling targets and the practical feasibility of possible changes.

Legislative text	Desirability of more stringent recycling targets		Practical feasibility
	In terms of % collected and recovered	In terms of deadlines	
Batteries Directive (2006/66/EC)	**Yes** Minimum collection rates imposed by the Directive are relatively low, so there is significant margin for improvement in the future and some MS have already exceeded the 2012 collection target.	**Yes** Several MS have already exceeded the 2012 collection target and the current recycling targets.	Difficult to assess since limited information is yet available on the implementation of this Directive. However, a recent study[200] estimated that a collection target of 80% would be feasible in the long term, based on current best practices identified in MS and technical capabilities; the same study considers that recycling efficiencies for Ni-Cd and lead-acid batteries appear to be close to their potential value at present, while for other battery types increasing the recycling efficiency target from 50% (current level) to about 70% would seem feasible in the long term.
Packaging Directive (94/62/EC)	**Yes** Increasing quantities of packaging put on the market, especially glass, metals, paper and cardboard, plastics; also an increase in use of wood in packaging Increasing recycling can achieve high environmental benefits; one of most cost-efficient methods of reducing CO_2 emissions	**Yes/No** Yes because targets already largely achieved No because need to allow newer MS additional time to comply	**Not very feasible** Studies indicate that an increase in recycling targets beyond current levels would not be cost-effective; while a number of MS have achieved high recycling rates, they appear to be struggling to maintain or further increase these rates

[200] BIO Intelligence Service et al., 2011, Analysis of the key contributions to resource efficiency, Final Report for DG ENV

End-of-Life Vehicles Directive (2000/53/EC)	**No/Yes** No: Current targets address potential increases in the weight of ELVs, which could lead to increased environmental benefits; environmental benefits achievable via the 2015 targets have been estimated by the Commission as being maximal Yes: Increasing recycling of certain types of plastics could lead to increased environmental benefits and higher recycling targets for metal would make it possible to increase recycling of metals currently lost in landfills due to poor separation of shredder residue	**No** Current deadlines not yet met, non-conformity cases still pending	**Not very feasible** Existing targets for 2015 are already a 'stretch' and are expected to stimulate eco-innovation and provide economic and environmental benefits. The costs of extending rates much beyond current levels rise extremely steeply because of the increasing labour input per kg treated
WEEE Directive (2002/96/EC)	**Yes** The most positive environmental improvement and highest cost-efficiency can be realised by rearranging the product oriented scope towards a treatment category oriented scope, hence allowing for a differentiation in target setting for collection amounts, recycling percentages and treatment requirements Due to their high environmental impact, for cooling and freezing appliances proper removal of CFC should be prioritised over high recycling %. Large household appliances could be left out of the Directive as they will be treated anyway due to their intrinsic value Small household appliances have higher chances of leakage to domestic waste disposal and large differences in performance across different MS and systems has been found, hence most positive option is to develop BAT/industry standards on dealing with small HH appliances Cathode Ray Tubes (CRTs) will go down to zero over time, due to their lead content and concerns linked to illegal shipments, collection should be maximised For LCD screens and lamps, strict target setting for mercury removal should be privileged over higher recycling targets Collection of small household appliances is very low, need to put in place measures to encourage consumers to turn in end-of-life products 4 kg/inhabitant does not reflect economies of individual MS and hence leads to sub-optimal targets for some MS and overly ambitious targets for others	**Yes** 2006 targets have not yet been fully reached and future targets must be defined or re-aligned with current failure to meet targets	**Very feasible** The WEEE Directive is currently being recast and the proposal for recast does include more stringent targets, taking into account the issues identified in the implementation of the current Directive

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