IMAGINE THE RESULT

Final report

Analysis of the evolution of waste reduction and the scope of waste prevention

European Commission DG Environment

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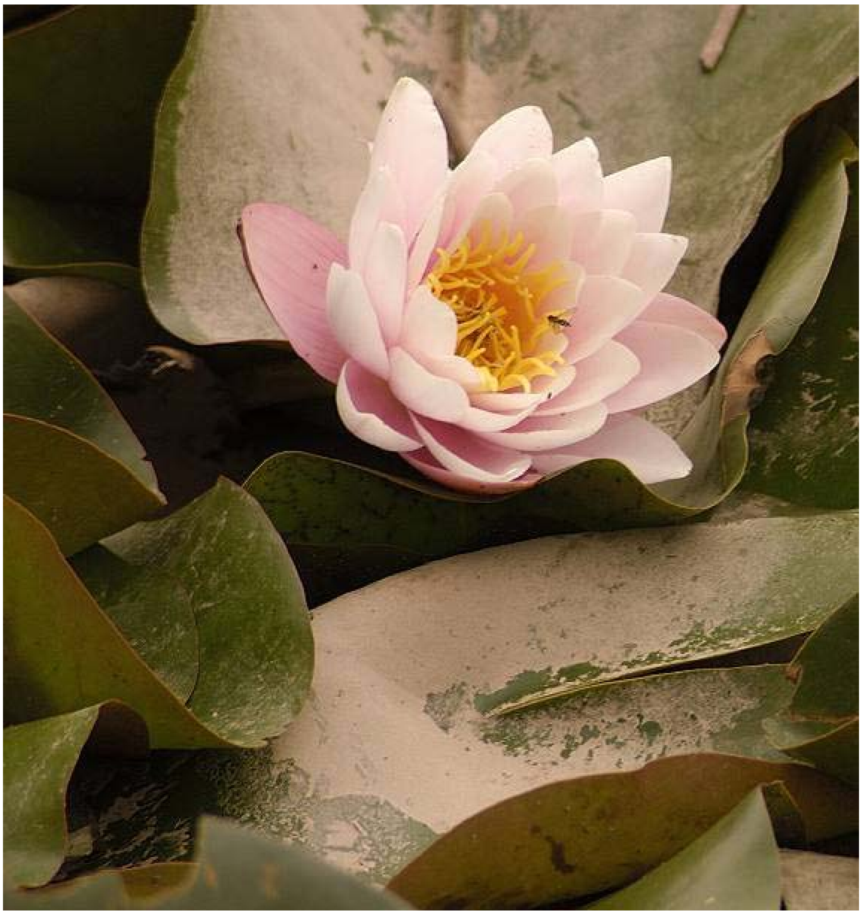

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Abbreviations

AD	Anaerobic digestion
BAT	Best Available Technology
BREF	BAT Reference Document
C&D	Construction and Demolition Waste
CE	CE Marking on a product is a manufacturer's declaration that the product complies with the essential requirements of the relevant European health, safety and environmental protection legislation
CEN	European Committee for Standardization, providing European Standards and technical specifications
CEI	OECD Core set of Environmental Indicators
CEPI	Confederation of European Paper Industries regrouping the European pulp and paper industry and championing this industry's achievements and the benefits of its products.
COMEXT	Eurostat's COMEXT database contains the official European Foreign Trade Statistics. It includes detailed statistics on the intra- and extra-trading in goods of all EU member states.
DE	Domestic Extraction
DF	Economic Driving Force
DMC	Domestic Material Consumption
DMI	Direct Material Input
DPSIR	Framework for describing the interactions between society and the environment and adopted by the European Environment Agency. The components of this model are Driving forces, Pressures, States, Impacts and Responses
EEE	Electrical and Electronic Equipment
EEA	European Environment Agency
EEB	European Environmental Bureau, Europe's largest federation of environmental organisations
EIONET	European Information and Observation Network
EIPRO	Project of JRC on the Environmental Impact of Products
ELCD database	Database comprising Life Cycle Inventory (LCI) data from front-running EU-level business associations and other sources for key materials, energy carriers, transport, and waste management
ELV	End-of-Life-Vehicles
EMAS	EU Eco-Management and Audit Scheme (EMAS), a management tool for companies and other organisations to evaluate, report and improve their environmental performance
EMS	Environmental Management System

EOW	End-of-waste
EP	Environmental Pressure
EPD	Environmental Product Declaration
EPR	Extended Producer Responsibility
ESM	Environmentally Sound Management of waste
ETC-RWM	European Topic Centre on Resource and Waste Management
ETC-SCP	European Topic Centre on Sustainable Consumption and Production
EUROPEN	European Organization for Packaging and the Environment
EUROSTAT	Statistical Office of the European Union. Its task is to provide the European Union with statistics at European level that enable comparisons between countries and regions
EU-27	European Union of 27 Member States
EWC-Stat	Waste Statistical Nomenclature according to Waste Statistics Regulation Regulation (EC) No 2150/2002, an aggregation of the European Waste List for statistical purposes
EWL	European Waste List, is a catalogue of all waste types generated in the EU established by Commission Decision (2000/532/EC)
EW-MFA	Economy-Wide Material Flow Account
FEAD	European organisation representing EU's waste management industry
FOE	Friends of the Earth is an international network of environmental organizations in 70 countries
GBI	Green Business Initiative
GDP	Gross Domestic Product
GVA	Gross Value Added
Import EU-27	imports to EU27 from outside the EU
IPP	Integrated Product Policy
IPPC	Integrated Pollution Prevention and Control (Directive 2008/1/EC)
JRC	Joint Research Centre
KEI	OECD Key Environmental Indicators
kt	Kilotonnes, thousand tonnes
LCA	Life Cycle Analysis
LCI	Life Cycle Inventories
MAMBO	Minder Afval Meer Bedrijfsopbrengsten, software tool of the Flemish Waste Agency to calculates the financial burden of waste and works under the slogan of “Less waste, more revenue”
MCA	Multi-Criteria Analysis
MFA	Material Flow Account / Accounting

MS	Member State of the European Union
MSW	municipal solid waste
Mt	Megatonnes, million tonnes
NACE	Nomenclature of Economic Activities
ODS	Ozone Depleting Substance
OECD	Organisation for Economic Co-operation and Development
OVAM	Flemish Waste Agency (Openbare Vlaamse Afvalstoffenmaatschappij)
PBB	Polybrominated biphenyls
PBDE	Polybrominated diphenyl ether
PCBs	Polychlorinated biphenyls
POP	Persistent Organic Pollutant (Regulation (EC) No 850/2004)
POS	Point of Sales marketing
PPS	Purchasing Power Standards. artificial common reference currency unit used in the European Union to express the volume of economic aggregates for the purpose of spatial comparisons in such a way that price level differences between countries are eliminated. Economic volume aggregates in PPS are obtained by dividing their original value in national currency units by the respective PPP. 1 PPS thus buys the same given volume of goods and services in all countries, whereas different amounts of national currency units are needed to buy this same volume of goods and services in individual countries, depending on the price level. www.eurostat.eu
PRODCOM	Eurostat's PRODCOM database contains statistics on the production of manufactured goods
R&D	Research and Development
REACH	Regulation 1907/2006/EC of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals
RoHS	Directive on the restriction of the use of certain hazardous substances in electrical and electronic equipment 2002/95/EC
RReuse	Specialised European network of national and regional social economy federations and enterprises with activities in re-use and recycling
SMEs	Small and Medium Entreprises
TMR	Total Material Requirement
UNEP	United Nations Environment Programme
WEEE	Waste from Electrical and Electronic Equipment
WFD	Waste Framework Directive 2008/98/EC
WGWPR	OECD Working Group on Waste Prevention and Recycling
WRAP	Waste & Resources Action Programme in the UK (www.wrap.org.uk)

Country Abbreviations

BE	Belgium
BG	Bulgaria
CZ	Czech Republic
DK	Denmark
DE	Germany
EE	Estonia
IE	Ireland
GR	Greece
ES	Spain
FR	France
IT	Italy
CY	Cyprus
LV	Latvia
LT	Lithuania
LU	Luxembourg
HU	Hungary
MT	Malta
NL	Netherlands
AT	Austria
PL	Poland
PT	Portugal
RO	Romania
SI	Slovenia
SK	Slovakia
FI	Finland
SE	Sweden
GB	United Kingdom

Analysis of the evolution of waste reduction and the scope of waste prevention

1 Executive summary – Key findings

1.1 Mapping of waste prevention

1.1.1 Analysing the scope of waste prevention

1.1.1.1 Short reference to methodology

The report analyses through detailed literature research the definitions of waste prevention, both in the Waste Framework Directive, several subordinate legal instruments at community level and at national levels, the use of the concept 'waste prevention' by EEA ETC/SCP, OECD and Basel Convention. It positions waste prevention in the DPSIR cycle and in the material flow chain, and it splits up waste prevention policy measures on its instrumental characteristics.

To analyse the scope of waste prevention the study covers some specific key questions: the relation between reuse and prevention, possible trade off between qualitative and quantitative prevention, and the border line between recycling and prevention.

It further focuses on a possible taxonomy for waste prevention activities.

In a major second part this chapter designs a visual map for waste prevention strategies, split up over factsheets based on an instrumental division, and factsheets based on the different stages of the life cycle.

Frames with practical examples illustrate throughout the text different more detailed aspects of scoping waste prevention, like home composting versus prevention, food waste prevention, life cycle analysis on reusable bottles, LCA on dematerialised services like Amazon Kindle, effective inspection on qualitative prevention, awareness raising on the Essential Requirements for Packaging and Packaging waste, awareness raising on cost reductions though prevention, applying RoHS and REACH on products and substances, Essential Requirements for packaging interfering in the decision process, waste less distribution systems, integrating risk analysis in the evaluation of transfrontier shipments of waste, etc.

Finally a questionnaire probes the opinion of different selected stakeholders on key issues. Their high quality feedback is integrated in the analyses above.

The bottom line conclusion of this exercise is an overview of key characteristics to scope waste prevention.

1.1.1.2 Key findings on the scope of waste prevention

The actual definition of waste prevention still serves its purpose

The definition as included in the Waste Framework Directive remains the most important touchstone for the description of waste prevention, not only because it exists and it is legally embedded, but also because it focuses all major essential aspects of scoping waste prevention:

> *Art. 3.12: Measures taken before a substance, material or product has become waste, that reduce: (a) the quantity of waste, including through the re-use of products or the extension of the life span of products;*

(b) the <u>adverse impacts</u> of the generated waste on the environment and human health; or

(c) the content of <u>harmful substances</u> in materials and products

Prevention includes measures taken before a substance, material or product has become waste. These measures include:

(a) reduction of the quantity of waste, including through the re-use of products or the extension of the life span of products;

(b) reduction of the adverse impacts of the generated waste on the environment and human health;

(c) reduction of the content of harmful substances in materials and products.

This can however be condensed to two main aspects: prevention of waste generation (quantitative prevention), and prevention of harm through waste (harm prevention).

Quantitative prevention and harm prevention are to be combined

Both aspects are closely joined together and cannot be balanced. They should both remain included in the scope and definition of waste prevention.

This is however no evidence: When waste or waste treatment does not have any noxious impacts, why should its generation be prevented? Vice versa, when the generation of the waste is obviated, it cannot cause any environmental impact or harm.

- When waste or waste treatment does not have any noxious impact, it does not imply that its generation should not be prevented. By definition, waste is a formerly useful material that can no longer be used, and as such, it is a lost material resource (if not recycled). The energy, water, space or other natural resources to make this material available and to bring it into a useful form is also lost, while recycling would require supplementary natural resources.
- Only if a product is not produced at all or never enters the waste chain (100% quantitative prevention), qualitative prevention on toxic components in the waste phase is not needed. Since this is not realistic, both concepts have to be applied on every product.

When qualitative prevention has been performed, this does not mean that quantitative prevention is no longer needed. Also, if quantitative prevention has been performed, this does not mean that qualitative prevention on the remaining or non-avoidable waste is not needed any more. Both aspects are not exclusive but rather supportive of each other.

Waste prevention in the design phase is the more effective

Waste prevention is a horizontal action taking place in all steps of the material flow, over extraction, production, distribution, consumption, waste and end-of-waste phases. Waste prevention 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 through design takes place before the material flow starts, in the phase where decisions of a strategic or technical nature are taken. The design phase includes more than the product oriented eco-design, but it includes as well commercial strategy development, market positioning, spatial planning, etc. Qualitative and quantitative prevention through design for environment is designing products that require less material input, less hazardous substances input, less need for packaging, less need for frequent replacement or maintenance… At the same level but even earlier and at a more strategic level in the decision process waste prevention can occur when a service is chosen in stead of a physical product to serve the same purpose (dematerialisation), or when a strategic choice is made not to develop a certain product or not to develop a certain market.

Waste prevention cannot be defined by referring to a kind of policy instrument

Prevention can be realised using legal provisions, voluntary agreements, economic instruments and incentives, communication and suasion, leading to strategic decisions or technical measures. Based on the DPSIR model, prevention is a policy response interacting with mainly driving forces and pressures, and in case of harm prevention also with state and impact.

The distinction between reuse and preparing for reuse is merely of a legal, and not of a technical or environmental nature

Reuse as a concept is strongly embedded in the definition of prevention, as included in the Waste Framework Directive, by the wording: "*including through the re-use of products or the extension of the life span of products"*. Reuse itself is defined as *"any operation by which products or components that are not waste are used again for the same purpose for which they were conceived*". From a technical point of view reuse can be split up in:

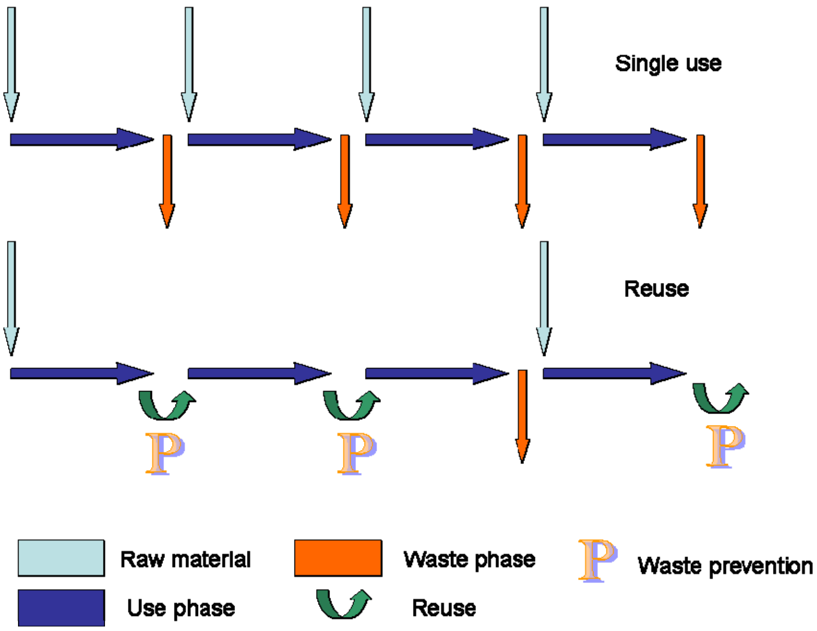
- Straight reuse, possibly by someone else, possibly in a different way.
- Refurbishment: cleaning, lubricating or other improvement.
- Repair: rectifying a fault.
- Redeployment & cannibalisation: using working parts elsewhere.
- Remanufacturing: the only option that requires a full treatment process – like new manufacture – to guarantee the performance of the finished object.

If performed on waste these measures are defined as 'preparing-for-reuse', if performed on a non-waste, they are 'reuse'. The distinction between 'preparing-for-reuse' as another operation in the waste treatment hierarchy, and 'reuse' as a prevention measure is fully dependent on the distinction between a waste and a non-waste. It does not solve the problem but only renames it. It is not useful to exclude 'preparing for reuse' and to include 'reuse' in the waste prevention scope. When the concept of 'waste prevention' would be extended to 'prevention in material cycles' (see 0) this more academic distinction would become irrelevant.

Reuse is waste prevention

Reuse is a form of waste prevention, at two different levels. Reuse temporarily prevents that a material or product enters the waste phase, but reuse also prevents the quantity of products entering the waste phase, especially in a replacement market. The production of new products (that at the end will become waste) are postponed and diminished. The figure below illustrates a situation where a product (e.g. a packaging) is reused three times before it enters the waste phase:

Figure 1: Reuse leads to prevention



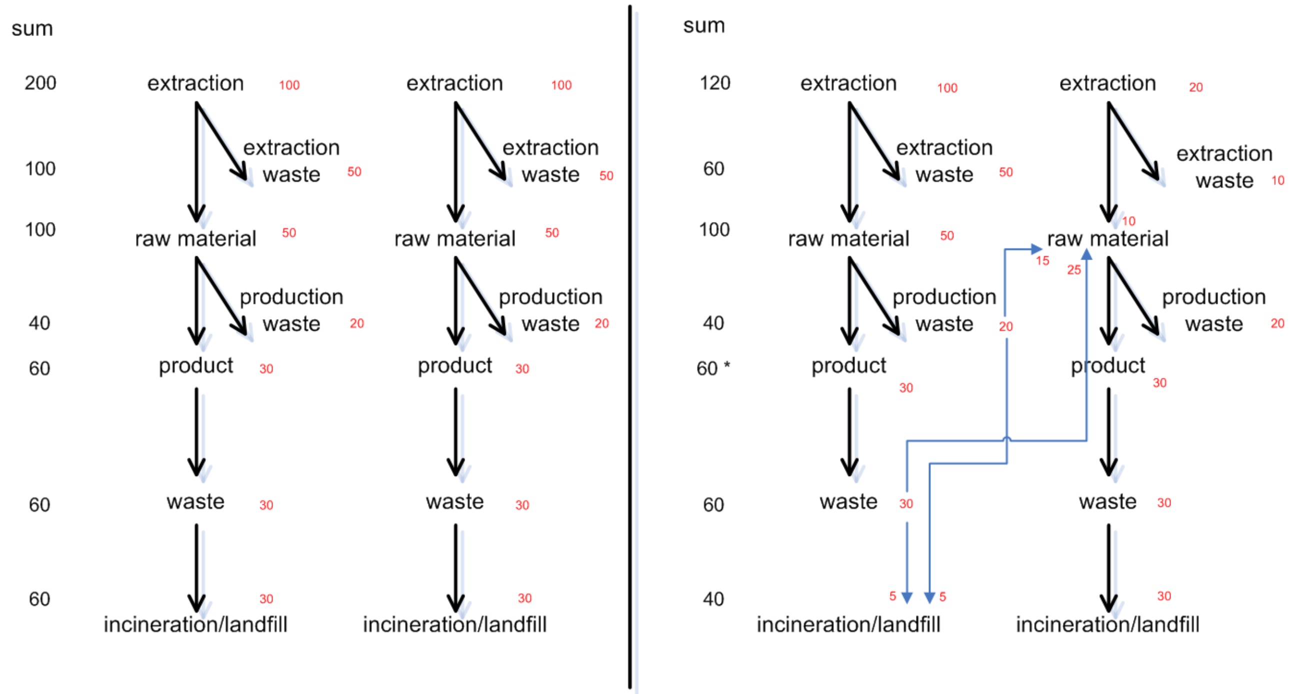
Reuse can lead to perverse effects when combined with export to non-OECD countries

Reuse or use as second-hand, especially when exported to non-OECD countries, should be evaluated taking into consideration the expected remaining lifespan and the expected fate of the product when it finally enters the waste phase. But the same argument is valid for the export of newly made low quality products, e.g. as a replacement for good quality second hand. Qualitative prevention can be the key to the solution on the issue of reuse in non-OECD countries with limited treatment capacities. A life cycle evaluation is needed to appreciate the environmental benefits and desirability of reuse in a given economic and technological frame.

Recycling and prevention are connected, but request a different approach

Recycling focuses on the treatment of a product when it already has entered the waste phase and when it is not fit to leave this phase by preparing-for-reuse. Prevention requires different decisions and different policy measures than recycling or recovery. Design for recycling does not equal design for longevity. It is therefore important to clarify the distinction between the different steps of the waste treatment hierarchy.

However recycling leads to quantitative prevention as a side effect, like illustrated in the following calculated example:



A situation is compared where a product is produced, used, discarded and replaced by a new equivalent product that is produced, used and discarded. In the first scenario (left) no recycling is taking place. All waste is landfilled or incinerated. In the second scenario (right) recycling of the production waste and on the end-user waste takes place. No specific prevention actions take place. Black figures show the sum of material in each life cycle phase. Red figures show the split up of material in different material flows. Blue lines show the material flows caused by waste treatment e.g. from production waste partially to raw material (recycling) and partially to landfill (disposal). In both scenarios the same amount of raw material is used, the same amount of product is produced and the same amount of waste is generated, both in the pre-consumer and the post-consumer phase. Recycling leads automatically to prevention of extraction waste, and to diminishing of landfill or incineration, but does not lead to prevention of pre- or postconsumer waste.

Broadening the scope of waste prevention to environmental harm prevention

"Prevention" in an environmental context could be scoped as a concept larger than "waste prevention", including the elimination or reduction at source of material and energy consumption, waste arising (solid, gaseous, heat and liquid) and harmful substances. The general concept of environmental prevention can be related to other prevention concepts like fire prevention, illness prevention, disaster prevention… Prevention is defined by the UN-ISDR Secretariat as *"Activities to provide outright avoidance of the adverse impact of hazards and means to minimize related environmental, technological and biological disasters.* Waste prevention as a concept could be replaced by prevention in material cycles, focussing at more than only the waste phase, but still related to material use. It is a subdivision of over all environmental harm prevention which includes other environmental domains like air, water, space, energy, biodiversity, risk…

Environmental harm prevention could be *"Activities to provide outright avoidance of environmental and resource depletion impact and means to minimize environmental and resource depletion impact.* This mirrors the UN-ISDR definition.

Prevention in material cycles could be *"environmental harm prevention applied on material use"*. This is a specific kind of harm prevention, looking at materials and their distribution over environmental compartments like water, air, waste or soil during the complete material cycle from resource to waste and vice verse.

Waste prevention could be *"prevention in material cycles applied on the waste phase of materials"*. The focus is laid on materials that have reached the waste phase or on measures avoiding that materials enter the waste phase. It covers the more traditional and limited waste prevention focus.

There is no natural hierarchy between different waste prevention measures

In line with the statement above that reuse could have adverse effects, the impact of life cycle thinking should be considered when priorising prevention and waste prevention policy measures. Quantitative prevention stands not above qualitative prevention, direct reuse stands not above refurbishment etc… LCA is needed to define appropriate priorities in a case-by-case situation. However, life cycle thinking and life cycle analysis may not be used to dilute waste prevention actions. LCA does not integrate prevention criteria and specific dimensions. LCA studies and prevention programs are complementary approaches. Waste prevention is not subordinated.

Where article 4.2 of the Waste Framework Directive puts the waste treatment hierarchy in the perspective of life cycle thinking, this is hardly the case for waste prevention which remains on top of the hierarchy, compared to recycling, recovery or disposal. Prevention on non hazardous waste remains useful even if the waste could theoretically be treated without environmental impact. Prevention of harm can be considered as an essential step for the subsequent steps in the hierarchy or in the preferred treatment method according to life cycle thinking.

The Life Cycle Thinking (LCT) concept and quantitative tools such as Life Cycle Assessment (LCA) aim at providing an informed and science-based support to a more environmentally sustainable decision making in waste management. Life cycle thinking looks as the contribution over their life-time of products (goods and services) to various environmental impacts. Life Cycle Thinking considers upstream and downstream benefits and trade-offs. It seeks to identify environmental improvement opportunities at all stages across its life cycle: from raw material extraction and conversion, product manufacture, through distribution, use and eventual fate at the end-of-life stage. However waste prevention may start before these stages and includes design and market decisions. Life Cycle Thinking is considered complimentary to the waste hierarchy, helping to assess the benefits and trade-offs associated with the different options.

The draft ISPRA study "A technical guide to Life Cycle Thinking and Life Cycle Assessment in waste management for waste experts and LCA practitioners" applies LCT and LCA to highlight where waste prevention measures could pose a risk of actually increasing environmental impacts, rather than reducing them. For example, if taken too far, reduced packaging can result in the packaged product being damaged or lost more frequently and so more materials would be needed to deliver the same amount of packaged products. LCA is also considered useful for highlighting where waste re-use could pose a risk of actually increasing environmental impacts, rather than reducing them, e.g. through refurbishment or collection logistics.

Of particular importance is the choice of an appropriate 'system boundary' that describes what to include in or to exclude from the assessment.

Life cycle thinking may request an alternative material treatment hierarchy

Discussion with stakeholders led to following possible hierarchy, in which prevention in material cycles is present in a decreasing way:

1. Dematerialised services, without material loops
2. Services in closed material loops, where the material output forms the renewable input. Full cradle to cradle approach, with initial input and replenishment from sustainably managed renewable resources.
3. Services with input from renewable resources – a cyclic reuse phase – a waste disposal output
4. Services with input from non renewable resources – a cyclic reuse phase – a waste disposal output
5. Services with input from non reusable resources – a waste disposal output

- Resources include material, energy, land-use, biodiversity…
- Further detailing of this sequence can be made by considering a parameter of proximity, to avoid global haul of materials and products where it can be produced in local loops.

1.1.2 Visual map for waste prevention strategies

Following factsheets have been developed:

Table 1: Overview of instrumental and life cycle factsheets

instrumental factsheets	Lifecycle factsheets
1. awareness and education	13. lifecycle phase design
2. ecodesign	14. lifecycle phase extraction
3. extended producer responsibility	15. lifecycle phase production
4. green public procurement	16. lifecycle phase distribution
5. labelling / certification	17. lifecycle phase use
6. marketing	18. lifecycle phase waste
7. positive and negative financial stimuli	19. lifecycle phase end-of-waste
8. prevention targets	
9. product standards	
10. reuse	
11. technology standards	
12. voluntary agreements	

They are distributed as follows over instrumental and life cycle categories

Table 2: Visual mapping of waste prevention strategies

	Design (13)	Extraction (14)	Production (15)	Distribution (16)	Consumption (17)	Waste (18)	End-of-waste (19)
Legal instruments	• Product standards (9) • Prevention targets (8) • Green public procurement (4)	• Technology standards (11) • Product standards (9) • Prevention targets (8)	• Technology standards (11) • Product standards (9) • Prevention targets (8)	• Prevention targets (8) • Market entries (2)	• Prevention targets (8)	• Prevention targets (8) • Technology standards (11)	• Product standards (end-of waste criteria) (9)
Economic instruments	• Positive/negative financial stimuli (7) • Extended producer responsibility (3)	• Positive/negative financial stimuli (7)	• Positive/negative financial stimuli (7)	• Extended producer responsibility (3) • Positive/negative financial stimuli (7)	• Positive/negative financial stimuli (7)	• Extended producer responsibility (3) • Positive/negative financial stimuli (7)	
Communication / other	• Labelling (5) • Awareness raising/education (1) • Voluntary agreements (12)	• Awareness raising/education (1) • Voluntary agreements (12)	• Awareness raising/ education (1) • Voluntary agreements (12)	• Awareness raising/ education (1) • Voluntary agreements (12)	• Labelling (3) • Awareness raising/education (1) • Marketing (6) • Voluntary agreements (12) • Green public procurement (4)	• Awareness raising/ education (1) • Voluntary agreements (12)	• Awareness raising/ education (1) • Green public procurement (4) • Marketing (6) • Voluntary agreements (12)
Technical instruments	• Ecodesign (2)	• Technology standards (11)	• Reuse (through remanufacturing) (10) • Technology standards (11)	• Reuse (of packaging) (10)	• Reuse (reuse shops etc) (10)	• Reuse (reuse of parts) (10)	

The main report contains the detailed factsheets, offering a factual overview of present waste prevention policies.

1.2 Material flows and their impacts in the economy

1.2.1 Short reference to methodology

Because of the enormous number of waste streams, it is not feasible to target them all. In addition, not all waste streams have an equal environmental impact. Therefore, policies should address the waste streams for which specific waste prevention measures could have the largest impact on the reduction of the over all environmental impact. The life cycle of a (waste) product is often long and complicated. It covers all the areas from the extraction of natural resources, their design, manufacture, assembly, marketing, distribution, sale and use, to the eventual disposal of them as waste and their end-of-waste phases. Compared to traditional waste management, sustainable materials management adds a sustainability perspective and a life cycle perspective, managing the material chain as a whole. The outcome of this chapter is a quantitative description of the current EU situation and near future development regarding waste and material generation and prevention. The project scope does not allow building new models in a sufficient level of detail. Relevant information and data which already exist have been collected and used to draw a quantitative description of the EU material and waste flows. The description comprises the EU as a whole.

The future development assessment is kept in line with the parallel study “Preparatory study for the review of the thematic strategy on the prevention and recycling of waste”. It is based on a limited set of available data and uses GDP and demographic projections, expected evolutions in the composition of MSW, an assessment of the degree of coupling or decoupling of waste generation on economic driving forces and an application of the Kuznetz assumption that environmental impact grows but reaches a top level when economy grows. The assessment has been made for three groups of MS with comparable macro-economic and waste management conditions. The EU-27 assessment is made by counting these results together.

Key environmental impacts for the selected material flows are mapped out in two different ways:

- top down, based on Environmentally Extended Input-Output Analysis (EE-IOA), trying to describe the key impacts associated with the main material flows at macro level entering the EU economy.
- bottom up using additionally information on available public LCA data in the ELCD database for the materials constituting the selected material flows.

1.2.2 Key findings

In the main document a detailed estimate has been made of the amounts of data already available, in close consultation with EUROSTAT and the EEA. The main waste data source is EUROSTAT's data centre on waste, complemented by waste fact sheets collected and by studies on specific waste streams prepared by the EEA and the ETC-RWM. With respect to material inputs, EUROSTAT has collected a set of partly reported partly estimated data on the consumption of approximately 50 material types for the EU Member States in the period 2000 to 2005. This data set does not give the sector input, but the input for the country as whole. Upon official request, this data set has been made available to the present project by EUROSTAT.

The data collected are too voluminous to show all of them in the main report and are partly included in annex.

A selection of key figures is included in Table 3

Table 3: Selected actual key waste figures

total waste generation in EU-27 in 2006	2954 Mt
total generation waste by C&D sector in EU-27 in 2006	970 Mt
total generation of waste by mining and quarrying sector in EU-27	744 Mt
total generation of waste from households in EU-27 in 2006	218 Mt
total generation of mineral waste in EU-27 in 2006	1794 Mt
total generation of combustion waste in EU-27 in 2006	152 Mt
total generation of manure in EU-27 in 2006	130 Mt
total generation of metallic waste in EU-27 in 2006	102 Mt
total generation of animal and vegetal waste in EU-27 in 2006	101 Mt
total hazardous waste generation in EU-27 in 2006	89 Mt
total packaging waste generation in EU-27 in 2007	87 Mt
total secondary waste generation in EU-27 in 2006	157 Mt
total recycling in EU-27 in 2006	1137 Mt
total energy recovery in EU-27 in 2006	77 Mt
total other incineration in EU-27 in 2006	51 Mt
total other disposal (landfill) in EU-27 in 2006	1349 Mt
collection rate of lead acid batteries in EU15+CH+NO in 2002	17%
recycling rate of collected ELV, average for 24 EU MS in 2006	65%
collection rate for WEEE in EU-27 in 2006	22%
recycling rate of MSW in EU-27 in 2005	33%

Results of the future trends assessment:

- The total generation of MSW will increase slowly after a phase of more intense increase until 2016, driven by both demographic and economic changes.
- Landfill will drop, incineration will rise and stabilise from 2018 onwards, recycling of MSW fractions trends to stabilise after a shorter period of continued increase, composting trends to increase considerable, AD becomes more important as a source of green energy.
- Industrial and the sum of all other non-household waste streams have the tendency to increase
- Inert waste becomes more and more visible as it is better collected and kept out of the fraction of mixed waste.
- Landfill of industrial waste fractions tends to decrease, incineration of industrial waste increases until 2016 and then stabilises, although the total waste generation keeps increasing.
- Export of waste to non-EU-27 countries keeps increasing

The EU material flows are quantitatively described with emphasis on the material flows of domestic extraction, imports and exports. This is complemented as far as possible by material flows within the EU economy. The focus lies on the main material streams including metals, paper, glass, plastics, bio-waste and minerals. Data from existing environmentally extended input-output tables are used as a primary data source. Due to new technologies and new production and consumption patterns, for some major materials (e.g. plastics) considerate changes occur. Direct material input as a whole shows a slow growth with considerable fluctuations

A selection of key indicators is included in Table 4

Table 4: Material flow evolutions between 2000-2005, derived from Eurostat EW MFA 2009

	2000	2005	Average increase (%)
Total domestic extraction (DE)	6,415	6,488	0.2
Total Imports to EU-27	1,43	1,618	2.5
Total exports from EU-27	466	512	1.9
total DMI (DE + Imports)	7,844	8,106	0.7
domestic material consumption DMC (DE + Imports - Exports)	7,378	7,595	0.6
GDP in Billion Euro, constant prices	9,202	10,061	1.8
Resource productivity GDP/DMI in €/kg	1.17	1.24	

The EUROSTAT Questionnaire on Economy wide material flow accounts (EW MFA) from 04.02.2009 does not differentiate between products or wastes being imported or exported. Wastes imported for recycling are considered a raw material. For this reason table 4 cannot confirm or refute the statement that waste shipments are a net material leakage or not. Data on imported wastes are available and assessed at an average of 3.792 kt between 2000-2005. Waste recycled within the EU is assessed at 1.124 Mt. Glass is assessed to be recycled outside the EU for 1%, plastic for 55%, metal for 12%

and paper for 7%. No data for other waste streams are available. However only if less than 0,34% of the total amount of recycled waste would be recycled outside the EU there would not be a material leakage. The figures, even incomplete, show a considerable risk of material leakage through waste shipment. This is however by large compensated by the much higher imports of materials as products or as raw materials compared to the exports as mainly products. Material shortages through waste shipments will not occur at a general level, but may be problematic for specific rare material types.

From the entering material streams approximately 40% leaves the economy as waste in the same year. From this waste stream again 40% flows back to the economy to be recovered as a material or a fuel.

To understand the existing waste generation pathways and potential for improvement one needs to identify and assess many specific pathways through the economy taking into account the life time of products, the resulting waste and the potential for improvement. The economic system is very complex with many pathways for materials going through the economy through numerous processes and products. This makes a correct assessment very difficult from a top-down approach or very elaborate to track all these pathways individually from a bottom up approach. Furthermore the statistics on waste use different categories that are not directly related to material flows entering the economy.

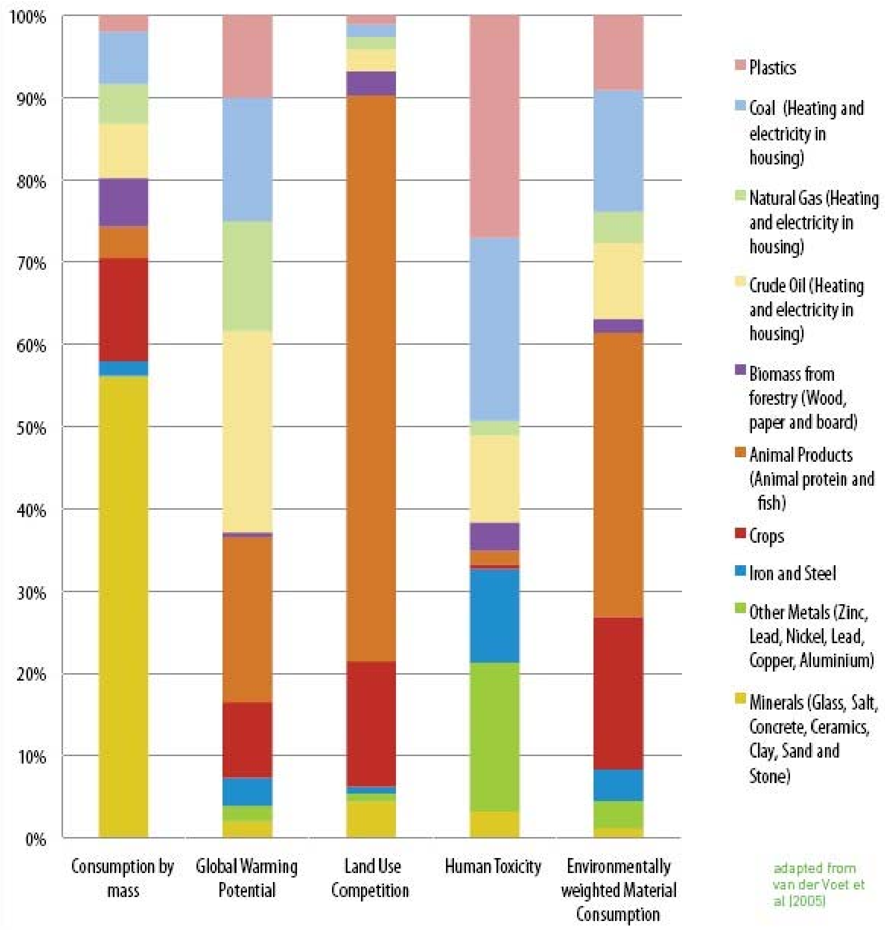
There is more stock in landfill than in existing products in use for most materials except for metals.

The minerals in stock are by far the most important volume in tons both in products in use (95 %) and landfill (75 %).

Biomass evidently is an important yearly material input stream but hardly contributes to stock building (only some wood and paper).

The most recent and authoritative review on assessing the environmental impacts of consumption and production has been published by the UNEP resource panel in May 2010 (Hertwich, 2010).

Figure 2: Relative contribution of groups of finished materials to total environmental problems



Main conclusions are:

- Minerals contribute very strongly to consumption by mass
- Crude oil, coal, natural gas, plastics but also animal products and crops are of the most importance regarding global warming.
- Animal products and crops dominate land use competition
- Plastics, metals, crude oil and coal have the largest impact on human toxicology

When aggregating these findings animal products, crops, coal, plastic, crude oil appear to be the main contributors to environmental impacts.

The environmentally extended Input-Output model of the EU EIPRO study priorised for global warming the product groups of: driving passenger car and motor vehicles, eating and drinking places, meat packing plants, heating, poultry slaughtering, new residential units, sausages and prepared meat, milk, cheese, washing with household laundry equipment. They already cover over 50% of the total life cycle emissions.

In order to quantify the environmental benefits of ideas for using less of less hazardous materials public LCA data from the ELCD database (still in development) at JRC Ispra are useful, although only a limited number of materials constituting the material flows are available yet.

1.3 Measuring waste prevention potential and impact

1.3.1 Short reference to methodology

The list of material and waste streams for which the potential is examined is set at: mineral, wood, bio-waste, plastics, paper and cardboard, glass, metals, hazardous material and waste, and MSW. The selection is partly inspired by data availability. The selection covers over 80% of all waste generated in the EU (excluding secondary waste from waste management activities). The list of policy strategies corresponds to the strategies in Table 2.

Based on the data retrieved via the Waste Statistics Regulation 2150/2002/EC a link is elaborated between waste data and the different life cycle stages. In order to estimate average environmental impacts for the selected materials, material categories were split-up into subcategories for which specific LCA data was available. The average impact for each category was then deduced from various production or domestic extraction data, allowing the weighting of the subcategories into each category. Four CML indicators, for which sufficient data was available, were evaluated for this analysis: greenhouse gasses emissions (CO2 eq.), resource depletion (Sb eq.), acidification potential (SO2 eq.) and eutrophication potential (PO43- eq.). Different formulas were used to calculate the potential environmental benefits from waste prevention of a tonne of production waste and end-of-life waste.

1.3.2 Key findings

Waste in the extraction phase is dominated by mineral wastes and bio-wastes. Waste in the manufacturing phase is very much related to the kind of manufacturing process. Waste in the distribution and consumption phases includes rather larger fractions of paper and card, bio-waste (food waste), and plastics and glass. Quantitative waste prevention potential for production waste can be found with wood, food, metal and mineral waste, and for end-of-life waste with mineral waste.

The life cycle impact assessment results were obtained by testing and comparing two “extreme” scenarios. In one case, recycling rates are assumed to be 0% for all materials, in the second one, all “recyclable” materials are assumed to be 100 % recycled. Few differences were found between preventing production and end-of-life waste. This is due to the fact that, from a material perspective, most of the environmental impacts occur during the extraction and manufacturing. Benefits from waste prevention are significantly lower for recyclable material in the 100% recycling scenario. In terms of GHG emissions, the highest benefits are obtained from preventing one tonne of plastic waste, followed by metallic waste and food waste, then paper and glass waste. Preventing one tonne of bio-waste represents by far the highest benefits on the three other indicators (acidification, eutrophication and resource depletion). Prevention of end-of-life waste shows relatively much higher benefits compared to prevention of production waste when observing the total potential benefits. In terms of GHG emissions, five waste streams represent comparable potential benefits, despite of the very different volumes generated: minerals, food, plastics, paper and metals. At the production phase, metals and food represent the highest potential benefits. Regarding the three other environmental indicators studied, food waste shows by far the highest potential benefits, both at the production and end-of-life phases.

1.4 Identification of areas for intervention

1.4.1 Short reference to methodology

A multi criteria analysis has been used to identify the areas presenting the highest potential for waste prevention, because very different aspects need to be compared with each other. The weight attributed to the different criteria corresponds to the importance the decision makers ascribe to the criteria. Two fundamental questions have to be solved to identify the areas of high potential for waste prevention:

- What are the most promising material flows?
- What are the most promising prevention strategies to apply on these waste streams?

This information obtained has to be checked with a third question; which policy strategies are compatible, or can überhaupt be combined with a given material or waste stream.

For each material flow three sets of independent evaluation questions have been answered;

- on potential for quantitative prevention
- on potential for qualitative prevention
- on life cycle aspects.

For each strategy four sets of independent evaluation questions have been answered

- on efficiency
- on feasibility
- on life cycle phase
- on societal aspects.

The sum of the score for the material and the score of the strategy is made and represented in a matrix. But as it is clear that not every strategy can with the same level of success be combined with every material stream. A correction on fitness to combine is applied. The result is illustrated by key examples.

1.4.2 Key findings

A comprehensive MCA and scoring exercise lead to following outcome as a matrix of high potential areas for waste prevention:

The material flows considered are those for which reliable data are available, covering a large fraction of all waste generated in the EU. To be consistent with the MCA methodology categories have to be selected in a way that they are mutually exclusive. This has been achieved for all waste categories, except for two more horizontally defined categories ‘hazardous waste’ and ‘municipal solid waste’. These fractions may in theory contain metals, plastics, glass, wood etc… However they can be considered as individual fractions as the quantities are based on EUROSTAT data from the Waste Statistics Regulation. The reported quantities for metals, plastics etc… only include individually reported fractions, and not the materials mixed up in mixed household waste or hazardous waste.

Table 5: Scores for material and waste flow potential

hazardous	2,3
metals	2,3
household (MSW)	1,8
bio-waste	1,8
plastics	1,6
mineral	1,2
wood	0,9
glass	0,5
paper and cardboard	0,4

Table 6: Scores for policy strategies potential

	score
ecodesign	4,39
product standards	3,04
marketing	2,94
reuse	2,94
labelling / certification	2,93
positive and negative financial stimuli	2,92
technology standards	2,74
green public procurement	2,72
awareness, education and other information	2,68
voluntary agreements	2,37
extended producer responsibility	2,22
prevention targets	1,87

Table 7: Matrix of high potential areas for prevention

		strategies											
		awareness & education	ecodesign	EPR	GPP	labelling / certification	marketing	positive/neg. financial stimuli	prevention targets	product standards	reuse	technology standards	voluntary agreements
material flows		1	2	3	4	5	6	7	8	9	10	11	12
mineral	1	7,77	5,59		7,85	4,13	8,28	8,24	6,15	8,48	8,28	7,88	7,15
wood	2	7,06	5,24		7,14	7,55	7,57	7,53	2,72	7,77	3,79	7,17	6,44
bio-waste	3	8,89			8,97	4,69	9,4	9,36	3,64	9,6		9	8,27
plastics	4	8,63	12	7,7	8,71	9,12	9,14	9,1	7,01	9,34		8,74	8,01
paper and cardboard	5	6,19	4,8	5,26	6,27	6,68	6,7	6,66	4,57	6,9		3,15	5,57
glass	6	6,34	4,88	5,41	6,42	6,83	6,85	6,81	4,72	7,05		3,23	5,72
metals	7	9,99	6,7	9,06	10,1	10,5	10,5	10,5	8,37	10,7		10,1	9,37
hazardous	8	10	**13,4**	4,55	10,1	5,26	5,27	10,5	4,2	10,7		10,1	9,4
household (MSW)	9	8,96						9,43	3,67				8,34

The results of the MCA indicate that hazardous waste and metal waste are the high potential areas for waste prevention, because of their high environmental impact and large amount of hidden flows. The most promising strategies for reducing both hazardous and metal waste would be ecodesign and product standards.

It should be highlighted, however, that due to limited data availability the MCA only gives a rough indication of high potential strategies, based primarily on expert opinion. Moreover, only the potential of single measures or strategies could be assessed. In practice, a waste prevention programme comprises a well combined set of mutually supportive measures or strategies.

REACH is an important instrument when trying to achieve effective waste prevention on hazardous wastes.

- REACH can play its full role in the post-waste lifecycle stages of a product, e.g. when it is recycled and reenters the market as a product or a non-waste raw material. The distinction between waste and non-waste is very important to assess the effect REACH can have.
- REACH can play a role in the qualitative prevention of the use of hazardous products that can end up in the waste phase. Both by excluding the use of certain substances, or by sharing information and thus sensitising the designer to use alternatives
- REACH plays a role in harm prevention when handling the waste fractions, because the exposure scenarios to be developed include the waste phase as an integrated part of the life cycle.

Quantitative effects of waste prevention measures are hard to assess. An estimate based on the above described modeling concludes that the average generation of waste could decrease with between 12 to 62 kg/inh in 2020, and total generation could decrease between 6 to 32 million tonnes, compared to the baseline. However compared to the actual situation assessed for 2010, both average and total waste still tend to increase.

1.5 Initial catalogue of indicators to measure and describe waste prevention

1.5.1 Key findings

1.5.1.1 Catalogue

- The effectiveness of prevention measures is very difficult to assess. Prevention is very hard to monitor directly, as it often adds up to “measuring what is not there”. To measure quantitative waste prevention is to measure a non-existent amount of waste. To measure qualitative waste prevention is to measure harm that did not occur. It is very difficult to exclude effects (market, demography, culture) other than prevention measures to assess the outcome effect of a prevention policy on waste quantities or qualities.
- Prevention policies are typical response actions in the DPSIR model, and require indicators to measure the response. Two different strategies are a direct assessment of e.g. the size or degree of participation on specific response actions (output indicators), or an indirect assessment of the results of the action on pressure and state (outcome indicators).
- If an output indicator depends upon a direct measurement of the application of an instrument, you have detailed information on the instrument but you do not know the

real impact of this instrument on the environment. If an outcome indicator measures the impact directly, you have detailed information on the impact but you are uncertain on the relationship between the instrument and the impact. Both categories of indicators cannot be integrated but they are both necessary to make meaningful judgements on the applied prevention policies.

- Output indicators deserving further analysis are e.g. the number of distributed anti-publicity or 'no thanks'-stickers for unsolicited mail, the use of second hand/reuse goods, the number of backyard composters, people participating in an opt-out list, enquiries on waste prevention attitude of households or industry, number of certified environmental management systems… At a supra national level output indicators have proved less suitable, since policies and instruments vary greatly among countries surveyed.
- Outcome indicators are e.g. the share of reusable household packaging, packaging per consumption unit, and the circulation of publicity folders. Pressure indicators on the drivers for waste generation can be considered as outcome indicators, as well as general statistics on the amounts of waste. Indicators based on material flow accounts are a specific type of pressure indicators. Indicators considered useful are the mere quantity of generated waste, in total, per capita, per GDP-unit. The OECD key environmental indicators and core set of environmental indicators are examples of this category, as well as the indicators used by EEA. Many more waste generation indicators can be proposed, e.g. based on the reported categories according to the first annex of the Waste Statistics Regulation.
- Decoupling is an important concept on which attention is paid in article 9, article 29 and in preamble (40) of the Waste Framework Directive: Prevention measures should pursue the objective of breaking the link between economic growth and the environmental impacts associated with the generation of waste. The Commission is required to set decoupling objectives by the end of 2014, and the Member States need to set out decoupling objectives and measures in their prevention programmes. The term "decoupling" has often been used to refer to breaking the link between "environmental bads" and "economic goods". Decoupling describes the relationship between the first two components of the DPSIR model, i.e. a change in environmental pressure as compared to the change in driving force over the same period.
- If GDP displays positive growth, "absolute decoupling" occurs when the growth rate of the environmentally relevant variable is zero or negative — i.e. pressure on the environment is either stable or falling. "Relative decoupling" occurs when the growth rate of the environmentally relevant variable is positive, but less than the growth rate of GDP. OECD states that the term decoupling is not used when the environmental pressure variable increases at a higher rate than the economic driving force. But this is as well a situation where environmental pressure is less or not coupled to its economic driving force. We introduce for these cases the term "negative decoupling".
- When distance-to-target is not taken into account, decoupling may be a good indicator for prevention.
- As a proof of concept decoupling is calculated for EU-27 for municipal waste generation compared to GDP, using three different approaches: the visual approach, the OECD formula and the enhanced OVAM formula. Decoupling can be demonstrated:

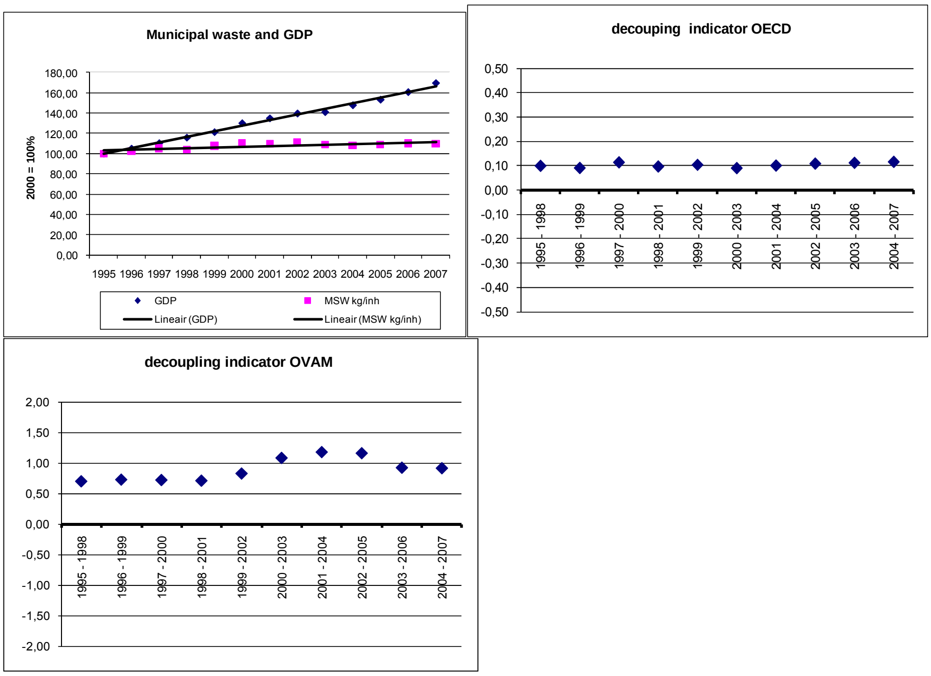


Figure 3: Decoupling indicator; visual, OECD, OVAM, for municipal waste generation in EU-27

1.5.1.2 Suitability

The suitability of the classes of indicators mentioned above is evaluated. A factsheet is developed which contains a short summary of the nature of the indicator, a description of the possible coverage of the indicator, in terms of prevention policies that can be covered, and an analysis of the effectiveness of the indicator, described as advantages and disadvantages, A state of affairs on the development and the use of the indicator, and a short assessment of the feasibility, depending on data availability, and the workload and data needed to calculate the indicator.

- Output indicators are looking directly at the prevention policy measure. It is, unlike an outcome indicator, strictly linked to individual instruments and takes into account the frequency of use of a specific instrument. It is not fit to cover all policy strategies. They are strictly linked to instruments and offer only limited information on the outcome. They can hardly be used at EU level.
- General waste statistics in its crude form are used to measure increase or decrease of waste generation. Because they are outcome indicators, it is difficult to link the indicator results to more specific prevention initiatives. The indicator can serve to see if prevention targets have been reached or to measure the distance-to-target. They are usually simple and straightforward indicators based on basic statistics on waste generation. Both the height of the absolute value of the indicator and its evolution in time deliver information. General waste statistics are defined at an EU-wide level, although still considerable work has to be done to make data reported by different Member States comparable. Waste statistics and waste policies (a.o. prevention targets) have to be more closely linked.
- Material flow accounting derived indicators: The indicator with the closest causal relation with waste generation is considered to be the Domestic Material Consumption (DMC) which is built up from Domestic Extraction (DE) plus Import minus Export.

Another possible indicator is Total Material Requirement (TMR). The coverage is comparable with the general waste statistics mentioned above. It is not useful to follow up individual prevention initiatives but it creates an overview of outcomes or results at an economy wide level. The DMC can be used as an alternative for directly measuring waste output. All material entering the economy will leave it by way of waste, sometimes after a short or long time of stock building in the economy. It can count for elsewhere unaccounted waste material flows. A disadvantage is that the indicators are limited to quantitative waste prevention. No distinction is made between waste and emissions into air, water or soil. DMC does not include hidden flows. This can be overcome by the indicator Total Material Requirements (TMR). MFA fits within the life cycle thinking where material is not only looked at in the waste phase but in its complete material flow throughout the economy. It can be expected that the importance of MFA will be rising in future.

- With composed complex indicators all kinds of indicators are covered which can be calculated based on pressures and driving forces, combining for example economic indicators with waste generation or material flow indicators. E.g.: ratio packaging versus packed product, resource productivity (=GDP/DMI)… These indicators are mainly outcome indicators, which can be tailored to serve a very specific goal. Complex indicators could be developed combining output and outcome indicators. A disadvantage is that complex indicators are multi-source indicators. The quality and reliability of the indicator depends on the quality and reliability or several independently collected basic data sets and on the often limited possibility to combine these data. Complex indicators often still are in the phase of development or experiment.
- A decoupling indicator is a specific form of a composed complex indicator. It always combines a driving force with a pressure. As driving forces can serve: economic parameters, but also demography or other societal aspects. Possible pressures include all quantifiable environmental pressures, not limited to waste generation or material use. E.g. decoupling from CO2 emissions from energy use, decoupling of waste generation from economic growth, decoupling of total use of hazardous substances from turnover of EEE … For waste it is usually limited to calculating decoupling between plain quantitative waste generation and economic growth. Decoupling is an outcome indicator with all properties of a composed complex indicator, as described above. It is not an indicator for prevention, but an indicator for what probably will be an observable effect of prevention. Decoupling does not mean that prevention takes place, but a first effect of effective prevention could be found in decoupling. A calculated and standardised decoupling indicator is needed to objectivise and substantiate claims on decoupling.

1.5.1.3 Headline indicators

A headline indicator is a suitable indicator, not for a specific policy instrument or a specific waste stream or sector, but for a global policy evaluation. It will be used at a high level of policy making, but also as a tool for communication or awareness raising. It should be robust, representative, it should allow time series and it has to be self-explaining. Furthermore it should possess all characteristics of any good indicator: pertinent, data are to be available, usable in different contexts, popular, compatible with Community data, mature, reliable and credible.

Because only by the end of 2014 prevention objectives could be formulated, the headline indicators proposed do not prefigure these objectives and may therefore need re-evaluation and refining. The indicators drafted are based on more or less readily available data and therefore are limited in there capacity to cover all environmental impact or resource use aspects of waste prevention policies. They are limited to output indicators that could cover quantitative and qualitative aspects, and to outcome indicators that are largely limited to mere quantitative waste prevention.

Headline output indicator:

Output indicators are usually not fit to be used as a headline indicator because they are too much linked to individual instruments which can differ from Member State to Member State. One overarching major output indicator can be based on the reporting from article 37 of the Waste Framework Directive. Member States have to report once every three year on a.o. the progress achieved in the implementation of the waste prevention programmes. The report shall be drawn up on the basis of a questionnaire or outline established by the Commission. The questionnaire to be developed can be the basis for standardised building blocks for an EU-wide waste prevention output indicator. Because of the nature of output indicators and of the approach through questionnaires and judgement of nationals waste preventions plans, this indicator will be based upon expert judgement and evaluation, possibly using a scoring system. It therefore will not always have the requested characteristics of simplicity, transparency or robustness.

Headline outcome indicator:

Because of the shift from mere waste policy to life cycle thinking it is important that an outcome indicator takes into account all phases of a material flow and not only the waste phase. It could therefore be advised to complement the main waste generation indicators with a MFA based indicator. Because of the impact of hidden flows, especially in the phase of raw material extraction situated largely in non EU-countries, and because of the increasing global character of environmental impact and resource use, the indicator Total Material Requirement (TMR) can be proposed. It includes:

- Domestic Extraction
- Plus Import
- Minus Export
- Plus Unused Domestic Extraction
- Plus Indirect Flows associated to Imports.

The ratio GDP/TMR could express the degree in which the development of our economy depends upon the use of materials and the environmental impacts and resource depletion effects that could depend from the quantity of material used.

1.5.1.4 Indicator complying with Art. 29.4:

The concept of decoupling is mentioned very explicitly in article 29 as in other places of the Framework Directive. Decoupling is, as mentioned above, not an indicator for prevention. It is also not the final scope of prevention. When relative or even absolute decoupling has been reached, prevention efforts still have to be continued, because the final scope of prevention is to reach a stage where the environmental pressure is limited below an absolute value which allows for sustainability.

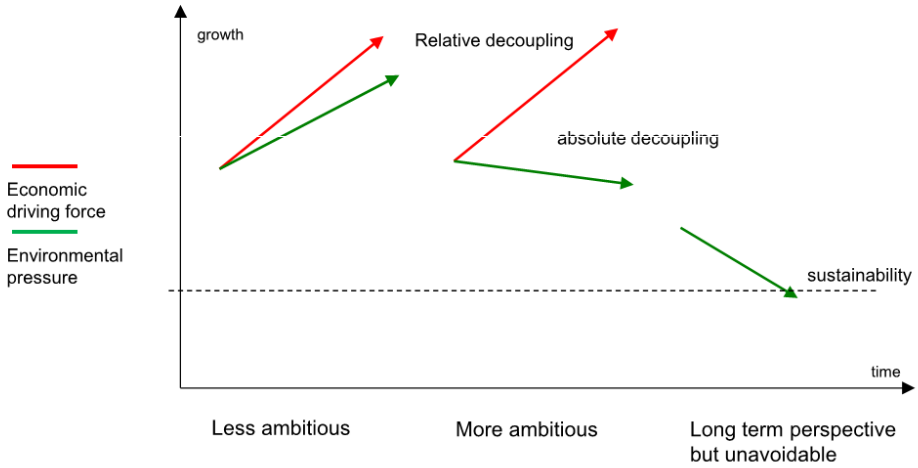


Figure 4: Decoupling and sustainability

The decoupling indicator we propose is based upon the ratio between the growth rate of the environmental pressure (EP) and the growth rate of the economic driving force (DF), for values of the five preceding years.

$$r_{y-5\rightarrow y} = 1 - \frac{b(EP)_{y-5\rightarrow y}}{b(DF)_{y-5\rightarrow y}}$$

Equation 1: Decoupling indicator, adapted formula

With

- $r_{y-5\rightarrow y}$ = the decoupling indicator for a time interval of five years from y-5 to y
- $b(EP)_{y-5\rightarrow y}$ = the slope of the linear regression of the environmental pressure (e.g. the waste generation) over the last five years
- $b(DF)_{y-5\rightarrow y}$ = the slope of the linear regression of the economic driving force (e.g. the GDP) over the last five years

Because of relatively easy access to basic data, we propose to define EP as total waste generation, possibly split up in the categories of waste or the categories of industrial activities as used in annex I and II of the Waste Statistics Regulation. DF is defined as GDP, if available GVA for specific sectors could be used as well. Alternative data for EP or DF can be included in the formula, based on the data needs and the possibly defined objectives.

The indicator is a value above or below zero.

- A positive value indicates possible positive decoupling
- A negative value indicates possible negative decoupling
- The distance to zero indicates the distance from a situation of perfect coupling
- If the value b(EP) $y-5\rightarrow y$ is negative itself, absolute decoupling can occur

We have to take into account that the formula as described above is not a simple relation between waste generation and GDP. It is the explicit intention of the regulator to have a more balanced and comprehensive indicator taking into account more aspects than merely the quantity of waste being generated. As illustrated in detail above the scope of waste prevention is much more differentiated, aiming, as described in article 29 of the Waste Framework Directive, to break the link between economic growth and the environmental impacts associated with the generation of waste. The formula above is applicable on all environmental impacts that are quantifiable, like resource depletion, land use, health impacts, degrees of self sufficiency, concentrations of hazardous substances, greenhouse gas emissions etc…

1.5.1.5 Conclusion – a set of indicators

The legal background for the use of prevention indicators is included in articles 9 and 29 of the waste framework Directive.

Article 29.3 states that *"Member States shall determine appropriate specific qualitative or quantitative benchmarks for waste prevention measures adopted in order to monitor and assess the progress of the measures and may determine specific qualitative or quantitative targets and indicators, other than those referred to in paragraph 4, for the same purpose."*

Article 29.4 states that "*Indicators for waste prevention measures may be adopted in accordance with (comitology procedures)"*

Article 9 states that Commission shall submit to the European Parliament and the Council reports and proposals for measures to support prevention activities and the implementation of the waste prevention programmes. By the end of 2014 waste prevention and decoupling objectives have to be set for 2020.

The chapter above offers the scientific background to develop indicators fit for developing and measuring targets in waste prevention plans, for communicating prevention results and for the setting of waste prevention and decoupling objectives.

One single indicator will not suffice to serve these multiple goals. A basket of complementary indicators will be needed.

- To formalise and make measurable the concept of decoupling an indicator as in paragraph 1.5.1.4 and a standardised scientific method has to be decided upon.
- Complementary to this calculation method, indicators have to be selected to describe correctly the environmental pressure for which decoupling will be examined. The above mentioned general waste statistics may serve this goal, as well as complex indicators describing in more detail qualitative or quantitative aspects. E.g. the degree of compliance with the Essential Requirements on packaging waste could be such an indicator.
- Because decoupling is one of the possible effects of prevention, but it is not the end-point of prevention, more general complementary outcome indicators have to be used. TMR can be proposed.
- Finally, it has been substantiated that output and outcome indicators have to be used in parallel, because the cause-effect relationship between prevention measures and environmental effects is sometimes complicated and not easy to measure directly. A complementary output indicator can be based upon quality control parameters for the development and the implementation of the waste prevention plans.

2 Introduction

2.1 Place of the study in the policy cycle

In 2005, the European Commission adopted the "Thematic strategy on the prevention and recycling of waste". The Strategy sets out guidelines for Europe to become a recycling society, a society that seeks to avoid waste generation and uses waste as a resource. A first step in the implementation of the Strategy was the adoption of the new Waste Framework Directive 2008/98/EC on 20 October 2008. The Directive introduces a new vision on waste management that encourages the prevention of waste, and sets new recycling targets.

Based on the subsidiarity principle, Member States must develop national waste prevention programmes, while the Commission is set to report periodically on progress concerning waste prevention.

Article 29 states:

"1. Member States shall establish, in accordance with Articles 1 and 4, waste prevention programmes not later than 12 December 2013…

5. The Commission shall create a system for sharing information on best practice regarding waste prevention and shall develop guidelines in order to assist the Member States in the preparation of the Programmes"

Article 9 states:

"Following the consultation of stakeholders, the Commission shall submit to the European Parliament and the Council the following reports accompanied, if appropriate, by proposals for measures required in support of the prevention activities and the implementation of the waste prevention programmes referred to in Article 29 covering:

(a) by the end of 2011, an interim report on the evolution of waste generation and the scope of waste prevention, including the formulation of a product eco-design policy addressing both the generation of waste and the presence of hazardous substances in waste, with a view to promoting technologies focusing on durable, re-usable and recyclable products…"

In addition, the Commission needs to formulate an action plan for further support measures in particular with regard to changing the consumption patterns by the end of 2011, and needs to set waste prevention and decoupling objectives by the end of 2014.

Two studies on waste prevention prepare the groundwork for the above reports on waste prevention required by the Waste Framework Directive. This study is the first part (Part A), providing some of the conceptual and numerical underpinning for the development of more specific work to be carried out in detail in the second part (Part B):

- Part A: The scope and potential of waste prevention, and initial work on indicators.
- Part B: Product design and consumption.

2.2 Objectives

The objective of this study is threefold:

- Defining the scope of waste prevention.
- Investigating the potential contribution of waste prevention to resource efficiency by analysing the current situation, ongoing trends in both waste generation and prevention, and forecasting future tendencies.
- Initiating work on waste prevention indicators by analysing the tools to measure waste prevention.

The study aims to provide clear, easily comparable and reliable figures which can be used by the Commission in its further elaboration of waste prevention policies and indicators.

The study makes primarily estimates of trends, developments and impacts based on the best available information from sources, such as EUROSTAT, the EEA, the OECD, institutes, business organisations, Member States and existing literature. It builds upon the “Preparatory study on the thematic strategy on the prevention and recycling of waste” and the study “Preparation of guidelines on waste prevention programmes according to the revised Waste Framework Directive, including best practices”. The analysis takes into account life cycle thinking.

It does not aim at a conceptual and academic exercise, but at clear and tangible recommendations.

2.3 Structure

The report is divided into five chapters reflecting five tasks:

- Task 1 – Mapping of waste prevention
- Task 2 – Mapping material flows in the economy and their impacts
- Task 3 – Measuring waste prevention potential and impacts
- Task 4 – Identification of areas for intervention
- Task 5 – Initial catalogue of indicators to measure and describe waste prevention

3 Task 1: Mapping waste prevention

3.1 Definitions of waste prevention

3.1.1 Detailed approach

The scope of this chapter is to provide a working definition for waste prevention: what is included in the term "waste prevention" and what is not included. The touchstone for this exercise is the definition as included in the Waste Framework Directive. It is compared with other occurring legal definitions and definitions used in literature on prevention and waste prevention, and with related definitions of reuse, qualitative prevention and other. The concept of prevention is situated in the DPSIR policy cycle, in the standard material flow, and in a typology of policy actions. Also the distinction between qualitative and quantitative prevention is been taken into account. Based on this approach an inventory and taxonomy is made on activities that can be classified as waste prevention. This taxonomy compiles and classifies the specific aspects of waste prevention activities. Specific cases or issues are added in text boxes to illustrate or complement the used concepts. The results of the literature and desk research are confronted with stakeholders and key witnesses, and a final set of characteristics of prevention is compiled that is used throughout the whole study.

3.1.2 Definition in the Waste Framework Directive

The definition of prevention as included in the Waste Framework Directive[1] is respected throughout the study. According to article 3 point 12 'Prevention' means

Measures taken <u>before</u> a substance, material or product has become waste, that reduce:
(a) the <u>quantity</u> of waste, including through the <u>re-use</u> of products or the extension of the life span of products;

(b) the <u>adverse impacts</u> of the generated waste on the environment and human health; or

(c) the content of <u>harmful substances</u> in materials and products

Key aspects in this definition have been underlined.

Before: prevention is what happens before a material becomes waste, and often even before the use of a material is decided upon, at the design table. However, as prevention measures can take place on materials that have already been generated, an important aspect in the use of the definition of prevention is the (ever difficult and disputed) border line between products, second hand products and waste. Although it is not the scope of the study, the 'end-of-waste' criteria and scenarios do influence the use of the legal concept of 'prevention'.

Quantity: quantitative prevention is rather self-explaining, as waste that has never been generated has no environmental impact and does not have to be treated or disposed of. The difficulty is not in the definition but in the measurement: how to measure waste that

[1] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives

does not exist. The decrease in waste production can be an indication for policy actions or initiatives from the producers. These actions can be defined as preventive actions or prevention, but only if a causal relationship can be defined or assumed between the action and its effect. The decoupling of economic growth and the generation of waste cannot be put on a par with prevention, but decoupling is one of the first indicators when quantitative prevention is successful.

Re-use is another central concept in the definition of prevention. The combination with the concept 'preparing for re-use', as step 2 in the waste treatment hierarchy, complicates and clarifies the definition of prevention in the first step of the same hierarchy. It needs to be examined how the interaction between these two concepts can be described.

Qualitative prevention can be defined as avoiding the adverse impacts of the waste and its treatment or avoiding the content of harmful substances, because these harmful substances could cause adverse impacts on the environment and human health. These adverse impacts may manifest themselves either in the waste phase, or as emissions from the waste treatment, or as harmful residues in products made from recycled material that could harm during its production, use, or subsequent waste phase. Qualitative prevention is a type of prevention that is not easy to quantify or to use when applying the waste treatment hierarchy. It can have direct relations with product standards or the use of hazardous substances (reach), with recycling and end-of-waste criteria, with the risk of exporting hazardous substances in waste to be recycled in non OECD-countries, etc.

Qualitative prevention does not exclude the application of other methods of waste treatment like reuse, recycling, recovery or disposal. Unlike quantitative prevention, it is therefore not easy to define qualitative prevention as an alternative for the other steps in the waste treatment hierarchy.

Potential trade-off effects between quantitative and qualitative prevention may occur.

3.1.3 Legal concepts, definitions and related terms

Apart from the definition in the Waste Framework Directive, as described in paragraph 3.1.2, additional definitions and descriptive information on the concept of waste prevention do occur in various sources:

- Within the EU waste management legislation a reference or a definition to waste prevention is not only found in the waste framework Directive (see paragraph 3.1.2) but also in some more specific legal instruments.
- European action or policy plans, and the European Topic Centre on Sustainable Consumption and Production (ETC/SCP).
- Non European bodies like the Basel Convention, the OECD and its working group on waste prevention and recycling (WGWPR).
- Some relevant local initiatives at Member State level.

3.1.3.1 Packaging and Packaging Waste Directive (94/62/EC)

*'**Prevention**` shall mean the reduction of the quantity and of the harmfulness for the environment of:*

- *materials and substances contained in packaging and packaging waste;*

- *packaging and packaging waste at production process level and at the marketing, distribution, utilization and elimination stages, in particular by developing 'clean` products and technology;*

In this definition the focus of prevention is broader than merely waste prevention. Both quantitative and qualitative packaging prevention include the packaging waste, the packaging and the materials used in the packaging. An explicit reference is made to the whole life cycle of the product, in casu the packaging, to ecodesign (clean products) and to clean technology.

*'**reuse**` shall mean any operation by which packaging, which has been conceived and designed to accomplish within its life cycle a minimum number of trips or rotations, is refilled or used for the same purpose for which it was conceived, with or without the support of auxiliary products present on the market enabling the packaging to be refilled; such reused packaging will become packaging waste when no longer subject to reuse;*

Reuse is not included in the definition of packaging prevention, but it explicitly refers to a non-waste phase preceding the waste phase. Reuse is defined in detail, referring to a minimum number of trips, and to explicit design for reuse.

EUROPEN mentions that prevention as defined in the Packaging and Packaging Waste Directive should not be linked to the definitions as used in the waste Framework Directive. The Packaging and Packaging Waste Directive is lex specialis to the Waste Framework Directive, meaning that it takes precedence over the Waste Framework Directive where packaging and packaging waste are concerned. This has been confirmed by the European Commission in its recent Communication on beverage packaging[2]. Unlike the Waste Framework Directive, which has the environmental Articles of the Treaty as its legal base, the Packaging and Packaging Waste Directive has the EU internal market Treaty Articles as its legal base, hence the aim and objective of these two Directives is not the same.

3.1.3.2 ELV Directive (2000/53/EC)

*"**Prevention**" means measures aiming at the reduction of the quantity and the harmfulness for the environment of end-of life vehicles, their materials and substances;*

*"**Reuse**" means any operation by which components of end-of life vehicles are used for the same purpose for which they were conceived;*

Article 4 of the Directive urges Member States on aiming at avoidance of hazardous substances and at an increased use of recycled materials. Article 7 contains reuse and recovery targets and repeats the preferred options in line with the waste hierarchy.

The definition of prevention does not mention, as in the Waste Framework Directive, the aspect of adverse impacts on the environment and human health. It does refer to quantitative and qualitative prevention. The definition of reuse does not make a statement

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[2] Communication from the Commission — Beverage packaging, deposit systems and free movement of goods (2009/C 107/01)

on the waste or non-waste status of the product that is reused, nor on a possible turning point between waste and non-waste.

3.1.3.3 WEEE Directive (2002/96/EC)

*‘**Prevention**’ means measures aimed at reducing the quantity and the harmfulness to the environment of WEEE and materials and substances contained therein;*

*‘**reuse**’ means any operation by which WEEE or components thereof are used for the <u>same purpose</u> for which they were conceived, including the continued use of the equipment or components thereof which are <u>returned to collection points</u>, distributors, <u>recyclers</u> or manufacturers;*

The ELV-Directive and WEEE-Directive use the same approach to define prevention and reuse.

Reuse can only occur when the product or components thereof are used for the same purpose as what they were originally conceived for. According to the WEEE-Directive, reuse is not impossible after being returned to collection points, distributors, recyclers or manufacturers, which implies that it is discarded by the original owner and is thus to be considered as waste. This is in line with the concept of ‘preparing for reuse’ as later introduced in the Waste Framework Directive.

Be describing reuse in the frame of waste being returned to recyclers one could argue that the concepts of prevention and recycling are somehow overlapping, or one should assume that recyclers could do more than merely recycling, but that they could also take care of the waste treatment method ‘preparing for reuse’.

3.1.3.4 <u>Directive 2009/125/EC</u> on establishing a framework for the setting of ecodesign requirements for energy-related products

*‘**Reuse**’ means any operation by which a product or its components, having reached the end of their first use, are used for the same purpose for which they were conceived, including the continued use of a product which is returned to a collection point, distributor, recycler or manufacturer, <u>as well as reuse of a product following refurbishment</u>;*

This Directive does not contain a definition of prevention. In its definition of reuse, which copies the definition in the WEEE Directive, it includes reuse after refurbishment or remanufacturing.

3.1.3.5 Thematic strategy on waste prevention and recycling

Implementing the Sixth Environmental Action Programme the Commission published a Thematic Strategy encompassing both recycling and prevention[3]. It was adopted on 21 December 2005 alongside a proposal for an amended Waste Framework Directive (COM(2005)667) and an impact assessment.

The aim of the Waste Thematic Strategy was to take stock of EU waste policy (including simplifying and clarifying the legal framework) and its achievements to date, look towards

[3] Thematic Strategy on the prevention and recycling of waste (COM(2005) 666 final)

creating a strategic framework for the future, and outline objectives and actions for the EU to move towards improved waste management, waste prevention and recycling.

The long-term goal behind the Waste Thematic Strategy is for the EU to become a 'recycling society' that seeks to avoid waste and use waste as a resource, thereby preventing waste generation, promoting recycling and recovery of waste, increasing resource efficiency, and reducing the negative environmental impact of natural resource use.

The Waste Thematic Strategy addresses waste prevention as one of the priority issues. According to the Strategy, although waste prevention has been the paramount objective of both national and EU waste management policies for many years, limited progress has been made in transforming this objective into practical action. Neither the Community nor the national targets set in the past have been satisfactorily met.

The Thematic Strategy does not contain a definition of prevention, but describes some of its major characteristics:

- Prevention can only be achieved by influencing practical decisions taken at various stages of the life cycle: how a product is designed, manufactured, made available to the consumer and finally used.
- Prevention policies should take into account national production and consumption patterns, their projected trends and their relation to economic growth.
- Prevention policies will focus on reducing environmental impact

Under the Framework contract ENV.G.4/FRA/2008/0112 a preparatory study is running for the review of the thematic strategy on the prevention and recycling of waste. The final report expected in September 2010. One of the key purposes is to further address the concept of the recycling society as not being a competitor to prevention.

3.1.3.6 European Topic Centre on Sustainable Consumption and Production

The European Topic Centre on SCP (ETC/SCP) is a consortium of eight specialist partner organisations from environmental authorities and research communities in Europe. The Topic Centre works under the European Environment Agency (EEA). Their vision and study efforts on waste prevention are based on existing European legislation and reports.

The Topic Centre reads the European legislation as follows: Waste prevention means measures aiming at the reduction of the quantity and the harmfulness for the environment of diverse waste streams.[4] More explicit the objectives of waste prevention are:

- Emission reduction
- Reduction of hazardous substances in material streams and of their dissipation
- Improvement of resource efficiency.

Prevention means eliminating or reducing the quantity of waste which is produced in the first place, thus reducing the quantity of waste which must be managed. Prevention can take the form of reducing the quantities of materials used in a process or reducing the

[4] http://scp.eionet.europa.eu/themes/waste/prevention/#introduction

quantity of harmful materials which may be contained in a product. Prevention can also include the reuse of products.[5]

Important in this approach is that the Topic Centre puts quantitative prevention before qualitative prevention.

The glossary of EIONET, the European Information and Observation Network that supports the three Topic Centres, only contains the definition as included in the Framework Directive.

According to the European Environment Agency, waste minimisation means *measures and/or techniques that reduce the amount of wastes generated during any domestic, commercial and industrial process. Minimisation includes any process or activity that avoids, reduces or eliminates waste at its source or results in re-use or recycling.*

It can be difficult to define a clear distinction between the terms "Prevention" and "Minimisation". Waste prevention and minimisation measures can be applied at all stages in the life-cycle of a product including the production process, the marketing, distribution, or utilisation stages, up to discarding the product at the end-of life stage.

Unlike in European legislation, the Topic Centre also recognises reuse where a product is used for a different purpose than it was originally conceived. Re-use means *the use of a product on more than one occasion, either for the same purpose or for a different purpose, without the need for reprocessing. Re-use avoids discarding a material to a waste stream when its initial use has concluded*.

3.1.3.7 Basel Convention

The principal devotion of the Basel Convention was the setup of a framework for controlling the transboundary movements of hazardous waste. In the present decade 2000-2010, one additional area of focus of the Basel Convention is the minimisation of hazardous (and other) waste generation. A central goal of the Convention is therefore the environmentally sound management (ESM) of waste. The aim of ESM is to protect human health and the environment by minimizing hazardous waste production, whenever possible. This strategy will be continued in the New Strategic Framework (NSF) 2011-2020 and is amongst others taken up in the following objectives of the Framework:

Objective 2.1: to reduce the quantities and hazardousness of waste

Objective 4.1: to encourage waste avoidance and minimization, promote sound recycling and reuse, promote awareness, increase resource revenues and raise the profile of the Convention.

The Basel Convention clearly aims at waste prevention and minimization, but the load of both terms is not precisely described. The original text contains a few references to both terms, both in the preamble and the body of the text.

…

Mindful also that the most effective way of protecting human health and the environment from the dangers posed by such wastes is the reduction of their generation to a minimum in terms of quantity and/or hazard potential

[5] http://scp.eionet.europa.eu/themes/waste

Aware of the need to continue the development and implementation of environmentally sound low-waste technologies, recycling options, good house-keeping and management systems with a view to reducing to a minimum the generation of hazardous wastes and other wastes,

…

The text of the Basel Convention enforces the Parties (members) to take measures to:

Article 4, 2

(a) Ensure that the generation of hazardous wastes and other wastes within (the country) is reduced to a minimum, taking into account social, technological and economic aspects;

(c) Ensure that persons involved in the management of hazardous wastes or other wastes within (the country) take such steps as are necessary to prevent pollution due to hazardous wastes and other wastes arising from such management and, if such pollution occurs, to minimize the consequences thereof for human health and the environment;

Article 13, (The Parties shall transmit each year a report on: (h) Information on measures undertaken for development of technologies for the reduction and/or elimination of production of hazardous wastes and other wastes.

Quantitative prevention is explicitly imposed, qualitative prevention only indirect through 'prevent pollution due to hazardous wastes'. Clean technology is promoted and the follow up of its development is enforced by a reporting obligation.

3.1.3.8 Organisation for economic co-operation and development (OECD)

The OECD and its Working Group on Waste Prevention and Recycling has a long track record in waste issues and sustainable use of materials in general. A three phase work programme on waste minimisation started of in 1994 with following key targets:

- Phase 1: inventory of existing policies and tools for waste minimisation
- Phase 2: development of common understanding of waste minimisation and its components (including recycling and sometimes even energy recovery)
- Phase 3: the prevention component of minimisation, which has led to a reference manual on strategic waste prevention in the year 2000[6].

After the year 2000, the primary focus moved to waste prevention indicators. From the various OECD-reports, it can be read that the vision on and definition of waste prevention has evolved over time.

The initial definition in the reference manual on strategic waste prevention (OECD, 2000) can be split up in two parts, addressing both the aim of waste prevention and the types of actions included in prevention:

Waste prevention aims at reducing both the quantity and the hazardous character of wastes. OECD countries achieved consensus understanding that waste prevention can be broken down into three types of actions: (a) Strict avoidance, (b) Reduction at source and (c) Product re-use:

[6] OECD (2000), OECD Reference manual on strategic waste prevention, ENV/EPOC/PPC(2000)5/FINAL, Paris

- (a) Strict Avoidance *involves the complete prevention of waste generation by virtual elimination of hazardous substances or by reducing material or energy intensity in production, consumption, and distribution*.
- (b) Reduction at source *involves minimising use of 'toxic or harmful' substances (since 2002 'hazardous' substances) and/or minimising material or energy consumption*.
- (c) Product re-use *involves the multiple use of a product in its original form, for its original purpose or for an alternative, with or without reconditioning*.

For each type of action, the report lists a number of examples to address quantitative or qualitative prevention.

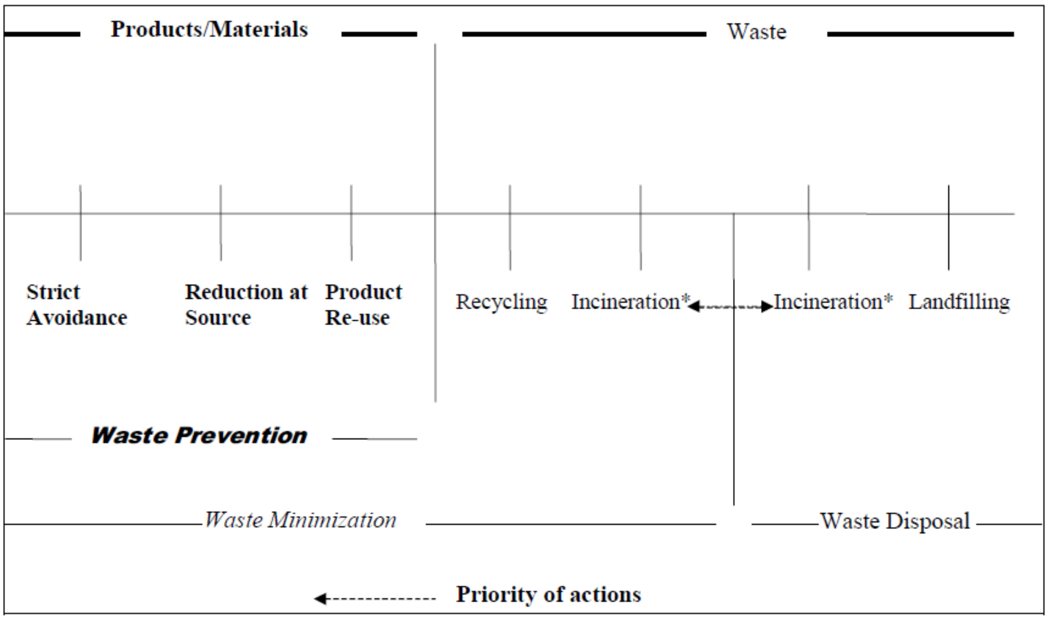
- Strict avoidance
  - Quantitative prevention: avoiding use of materials or stages of production/consumption (e.g., through eliminating interim packaging for cosmetics and toothpaste, or substitution of continuous casting for ingot casting at steelworks).
  - Qualitative prevention: avoiding and/or substituting materials that are hazardous to humans or to the environment (e.g., through bans on PCBs and ozone-depleting substances, or virtual elimination of toxic organochlorines released in bleached pulp mill effluents).
- Reduction at source
  - Quantitative prevention: Using smaller amounts of resources to provide the same product or service (e.g. reducing foil thickness, introducing re-use or refill systems, miniaturisation, resource-orientated purchasing and consumption); and using less resource-dependent construction principles and materials.
  - Qualitative prevention: Reducing the use of harmful substances in products, in production and sales systems, and in consumption and disposal systems, and reducing the use of substances that hinder re-use or recycling (e.g. "Post-its" on paper, use of chlorinated solvents as cleansing agents).
- Product re-use
  - Re-use after reconditioning, such as refilling glass or plastic bottles after washing or using empty adhesive barrels as oil barrels after reconditioning.
  - Re-use without reconditioning, such as using shopping bags more than once.

Other publications within the scope of the work on waste prevention indicators (OECD, 2002 and 2004) have used this same definition, with only minor changes in wordings:

Waste prevention aims to reduce the amount, <u>hazard character</u> or energy content of products or materials before they enter the waste stream. OECD (2004) replaces 'hazard character' by *'<u>the risk to the environment and human health</u>'*.

'Toxic or harmful substances' in the definition of reduction at source become *'hazardous substances'* in later publications.

The OECD underlines that confusion with related terminology (waste minimisation, recycling) should be avoided. Waste prevention is distinct from recycling and other waste management efforts which are applied only when products and materials are recognised as waste. Waste Minimisation is preventing and/or reducing the generation of waste at the source; improving the quality of waste generated, such as reducing the hazard, and encouraging re-use, recycling, and recovery. According to the OECD, waste prevention is part of the broader concept of waste minimisation (OECD, 2000). These terms and concepts and there relationships are graphically shown in Figure 5 below. According to this terminology, reuse, but not recycling, is a part of waste prevention. Waste diversion, not mentioned in the chart, refers to the reduction in the quantity of waste managed through disposal activities (OECD, 2004).



Source: Stutz 1999a. in OECD (2000)

Figure 5: Definition of waste prevention in relationship to waste minimisation

See also Figure 79, where Municipal Waste Europe presents a similar approach.

The concept of waste prevention and waste minimisation has evolved and differentiates from earlier OECD-positions. In 2003, the European Commission produced a guidance note prepared by the European Topic Centre on Waste and Material Flows on how to prepare a waste management plan. The document refers to an OECD-conference[7] of 1996 where definitions of waste minimisation and prevention were drafted. Prevention is one of the three elements of preventive measures. It was later renamed ‘strict avoidance’. Waste minimisation excluded energy recovery, which was later included in the concept. Waste minimisation also includes the waste management measures ‘quality improvements’ (such as reducing the hazardous substances), which was not seen as a preventive measure

Preventive Measures			**Waste Management Measures**			
Prevention	Reduction at source	Re-use of products	Quality improvements	Recycling	Energy recovery	Pre-treatment
Waste Minimisation						

[7] Building the Basis for a Common Understanding on Waste Minimisation, OECD Workshop October 1996 in Berlin

Figure 6: Older OECD definition of waste prevention and waste minimisation

Qualitative prevention is not addressed as a separate term by the OECD. Some reports use hazard-oriented waste prevention but strict definitions are lacking.

3.1.3.9 Definitions and concepts at Member State level

3.1.3.9.1 Austria

Waste prevention is recognized as one of the basic principles of the Waste Management Act (2002) and is defined as minimising the quantities of waste and their contaminants.

The Federal Waste Management Plan 2006[8] describes a more practical view on the fundamentals of waste prevention, by enumerating what waste prevention can include:

- *omitting hazardous substances and reducing material input during production, distribution and use;*
- *closing material cycles during production;*
- *"reusing" an object, i.e. the new intended use of an object (e.g. returnable bottles);*
- *"continuing to use" an object (the non-intended, yet permissible use of an object).*

The plan makes an additional differentiation between qualitative and quantitative waste prevention. Qualitative waste prevention means substituting environmentally harmful materials with more environmentally friendly materials while quantitative waste prevention is partial or complete renunciation of the use of materials or processes that cause waste.

The Austrian Waste Management Act does not include this definition as used in the Plan. The Austrian WEEE-Act (§3 (3)) however defines reuse of WEEE similar as the WFD as "measures where WEEE are used for the same purpose for which they were designed, including further use of appliances or their components which are brought to collection centres, retailers, recycling facilities or producers". It is clear that only Waste EEE are covered by this law, but this will be changed soon since Austria will implement shortly the complete WFD definitions into national law.[9]

3.1.3.9.2 Finland

The Waste Act (1072/1993), which entered into force on 1 January 1994, introduces the general obligation to prevent waste generation and to reduce its quantity and harmfulness. In order to implement the general obligation, the Government may issue general regulations concerning the production and marketing of products. Such regulations have so far been issued for example on batteries and accumulators, ozone depleting substances, asbestos and impregnated wood.

Section 4, general duties of care, in Chapter 2 of the Waste Act comprises elements that refer to the concept of prevention:

As far as possible, care shall be taken in all activities to minimize generation of waste and to ensure that waste does not significantly hamper or complicate the organization of waste management, or result in hazard or harm to health or the environment. Specifically:

1) the producer shall use raw material sparingly in production and substitute waste for raw material used;

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[8] www.bundesabfallwirtschaftsplan.at

[9] Communication RREUSE

2) the manufacturer of a product shall take care, and an importer likewise ensure, that the product is durable, reparable or reusable, or recoverable as waste, and that the product does not, as waste, result in any hazard, harm, or complication referred to above;

3.1.3.9.3 France

The definition of waste prevention used in the French national prevention programme[10] refers to the different steps in the material flow philosophy where preventive measures can be applied[11]:

Prevention: *Prevention measures can address all upstream stages of the product life cycle before wastes are collected by an operator or local authorities, starting from the raw materials extraction phase until reuse*.

The plan also refers to waste minimisation as a broader concept, including recycling. It is described as the reduction of waste quantities going to landfill or incineration. For municipal waste specifically, prevention then includes those measures that can reduce the material flows being collected by local authorities. Further distinction is made between avoided waste flows (*'Flux évités'*) and diverted waste flows (*'Flux détournés'*).

Avoided waste flows: *waste not being generated due to preventive measures as well as waste that does not enter the public waste management system because alternative (in-house) destinations have been found*. The user has found an alternative use for the product that will not yet be discarded (therefore avoided). Examples mentioned in the plan are home-composting, mulching and reuse for alternative purposes.

Unlike the French position, in this study home-composting is not considered as prevention but as recycling, although the waste never enters the official out-house collection or recycling circuit.

Diverted waste flows: *products taken up by organisations looking to extend the product's life or aiming at giving a second life to the product (for the purpose the product has originally been conceived).* These material flows are considered as waste because they have been discarded by the original user. The current or new waste holder does give the waste a new life for the same purpose as it was originally conceived and is no longer considered as waste. Examples of actions are repairing and refurbishment.

The plan further distinguishes between quantitative (the reduction in mass and volume of generated wastes) and qualitative prevention (the reduction of the harmfulness of generated wastes).

Frame 1: Home composting is not prevention

France considers waste that does not enter the public waste management system because alternative (in-house) destinations have been found as a type of prevention.

This can be read as:

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[10] Ministère de l'écologie et du développement durable, Prévention de la production de déchets, février 2004

[11] Own translation

- Industrial short cycle reuse schemes, where outfall of a production process is directly re-entered into the same process as a raw material without the use of a waste treatment or recycling stage.
- Household waste that never leaves the private context because it is legally treated or reused in the own garden.

The status of home composting is discussed within several Member States, as either prevention, because the waste never enters the regular waste collection and treatment chains. However, following arguments can be entered to consider home composting not as a prevention method but as a recycling method:

- The waste is actually generated, and needs to be treated. Home composing has to fulfil certain criteria to be distinguished from backyard tipping or other less desired individual treatment options.
- Home composing fulfils the definition of recycling method R03
- The ARCADIS study “Assessment of the options to improve the management of bio-waste in the European Union” shows that net welfare gains are to be made from home composting. Allowing home composting to be included in the recycling target accommodates the needs of areas with low population density.
- By not accepting all home treatment methods as waste prevention, it is easier to set up a regulatory frame for other desired or non desired methods: feeding home bread poultry, small livestock or other small scale private animal rearing; illegally disposal through backyard incineration; dumping; (illegal) disposal through sewer-based food-waste disposers…

Problems with the inclusion of home composting in the definition of recycling are:

- It is difficult to measure, e.g. in the light of recycling targets: The figures for the actual generation of bio-waste do not include waste treated through home composting. These figures are in most Member States based upon or derived from quantities of waste collected. Home composted waste is not collected and never enters an official waste treatment channel where it could be measured.

Home composting could be included as a (countable and good) recycling operation under following conditions:

- It should be home composting under application of an official stimulation programme where home composting vessels are subsidised or distributed to the population, and with accompanying programmes for the right home composting techniques. It then could be counted or assessed based upon the number of vessels distributed and an average composting capacity generated through these vessels.
- Regular sample surveys and analyses should define which percentage of vessels is used and which percentage of home generated compost fulfils the quality requests.
- The total assessed amount of waste home composted should be added to the amount of municipal bio-waste generated. The percentage of home composting leading to compost fulfilling the standards should be added to the amount of bio waste composted.

3.1.3.9.4 Ireland

Ireland is one of the European countries where waste prevention and minimization have long been integrated in Waste Plans. Under the Waste Management Act, 1996 (as amended), all local authorities are required to prepare and implement a Waste Management Plan. These plans include objectives in relation to prevention and minimization of wastes. The evolution of the concept of prevention and minimization are listed based on documents that defined these terms.

In 2002, the Irish government published a policy statement on waste prevention[12], where the definition of the term had been based on the WEEE-Directive 2002/96/EC being:

"measures aimed at reducing the quantity and the harmfulness to the environment of waste and the materials and substances contained therein".

Waste prevention initiatives can therefore be successfully applied at any time in the life-cycle of a material or substance, including in the production process, the marketing, distribution, or utilisation stages, up to eventual discard at the end-of-life stage. Prevention is the most desirable method of waste management since the absence of waste totally eliminates the need for handling, transportation and treatment of discarded materials. Prevention of waste provides the highest level of environmental protection. It optimises the use of available resources and removes a potential source of pollution.

Minimisation, on the other hand, means any technique, process or activity that either avoids, reduces or eliminates waste at its source, or results in re-use or recycling. Waste minimisation requires all stakeholders in the management chain to adopt a proactive role in reducing the quantity and harmfulness of waste ultimately sent for disposal and to choose products which create the least harm to the environment during production, in operation as well as in waste treatment.

Re-use means the use of a product on more than one occasion, either for the same purpose or for a different purpose, without the need for reprocessing. Re-use avoids discarding a material to a waste stream when the initial use of the product has concluded. It is more preferable that a product be re-used in the same state, since it will not then require additional processing involving a further input of energy and raw materials. Re-use can be increased through the repair and renovation of products, their donation to charitable causes or by direct resale of the used materials.

Further work on waste prevention had been prepared for the Irish Environmental Protection Agency in 2004. The study stated that it was first necessary to define prevention, in order to initiate a waste preventive framework for Ireland. The recommended definition[13] for waste prevention builds upon the one used in earlier EPA research report[12]: *The elimination or reduction at source of material and energy consumption, waste arisings (solid, gaseous, heat and liquid) and harmful substances*.

The synthesis report underlines that it was important that this definition would be officially recognised and promoted so that all those involved in waste matters are aware of what prevention entails (which is not the case). However, it should also be noted that when focusing on prevention, waste is not the only concern and the consumption of raw materials is of primary importance, since any material that enters our economic system

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[12] Waste prevention policy statement, Preventing and recycling waste – delivering change, Irish Governement March 2002 (DoELG, 2002a)

[13] Assessment and Development of a Waste Prevention Framework for Ireland (2001-WM-DS-1) Synthesis Report, Prepared for the Environmental Protection Agency by Clean Technology Centre, Cork Institute of Technology Authors: Tadhg Coakley and Dermot Cunningham - 2004

may have potential to damage the environment in its acquisition, processing, transport, usage, recovery and disposal. Nor should issues regarding energy be ignored. Furthermore, on the output side, prevention encompasses more than just waste (where waste is traditionally taken as solid). Gaseous and liquid wastes, waste heat, etc. are also included. Issues regarding equity and global responsibility are also important when considering prevention.

As regards what such a definition would mean in practice, it is worthwhile to look at the standard waste management hierarchy options and to suggest which of them should be included in 'prevention' as suggested in the figure below.

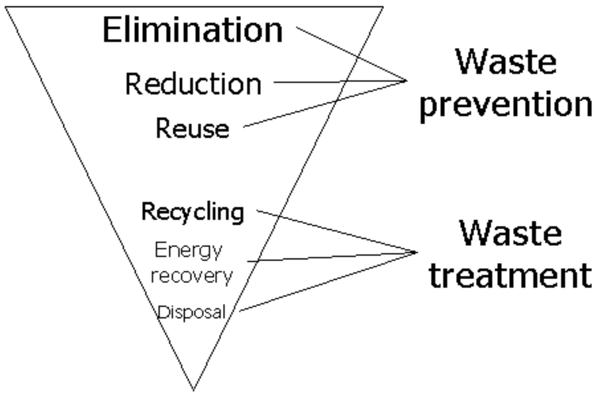

Figure 7: Irish definition of prevention in the waste treatment hierarchy

The updated Irish (Waste) Prevention Plan (2009 –2012)[14] defines Waste prevention as:

Elimination or reduction at source of:

- *Materials, Water and Energy Consumption*
- *Waste arisings (solid, liquid, gaseous and heat)*
- *Hazardous or Harmful Substances*

Thus any action that, for example, reduces the use of material resources, increases the efficiency of production/service processes, decreases water and energy consumption, or causes a reduction in the gross generation of waste (for disposal plus recycling) can be classified as waste prevention. In general, prevention may be achieved either by reducing the overall demand for goods and services, or by using less (or less harmful) resources to provide for reasonable needs. Prevention also seeks to reduce emissions, to reduce harmful substances in material streams and their dissipation, and to improve resource efficiency throughout the life cycle of a product or service.

3.1.3.9.5 The Netherlands

Waste prevention is an essential element of the Dutch waste policy plan 2002-2012 (LAP)[15]. Prevention comes prior to waste management and is not included therein. Waste management is described as the full chain of source separation, collection, transport, storage, treatment, recovery and disposal of waste.

[14] Environmental Protection Agency, Fifth annual report on the National Waste Prevention Programme, presented to the Minister for the Environment, Heritage & Local Government, October 2009.
[15] Ministerie van VROM Landelijk afvalbeheerplan 2002-2012 (LAP)

Waste prevention entails the elimination or the reduction of the generation of waste and emissions (quantitative) and the reduction of the environmental harmfulness of waste (qualitative).

Prevention does not solely relate to aspects of waste management. Prevention usually goes hand in hand with the reduction of materials and energy use in production processes and thus less pollution and degradation of the environment in the extraction phase. Prevention can also contribute to production efficiency and result in lower unit production costs and a better working environment.

3.1.3.9.6 Sweden

The current environmental strategy on waste for the Swedish Environment Protection Agency builds on five key priorities, where one task entails the focus shift towards reducing the volume and hazardous nature of waste. It is believed that these reductions are best controlled through product and chemicals management. Measures taken at the waste stage have only limited consequences for environmental impacts.[16]

A substantial part of the Swedish Waste plan (2005)[17] is dedicated to preventive efforts to reduce the quantity of waste and the hazards it poses. The amount of waste generated and how hazardous it is are determined as early as the product design phase. It is then that the quantity of materials used to manufacture the product and whether it will contain hazardous substances are decided. To achieve the objective of reducing the quantity of waste and the hazards it poses, waste must be seen as part of the manufacture and use of products.

Reduced waste quantities require more resource-efficient manufacture and products that require fewer materials and last longer. The most dangerous substances will have to be phased out and use of other hazardous substances reduced to lower the degree of hazard posed by waste. However, measures taken at the waste stage can be formulated to provide feedback on the products that are difficult to deal with as waste.

3.2 The position of waste prevention in a larger material or policy context

3.2.1 The position of prevention in the DPSIR cycle

DPSIR is a causal framework for describing the interactions between society and the environment, as adopted by the European Environment Agency. In recommendation to the European Environment Agency (EEA) on how they should proceed with the development of a strategy for Integrated Environmental Assessment, RIVM proposed the use of a framework, which distinguished driving forces, pressures, states, impacts and responses. This became known as the DPSIR framework and has since been more widely adopted by the EEA, acting as an integrated approach for reporting, e.g. in the EEA's State of the Environment Reports.[18]

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16 http://www.naturvardsverket.se/en/In-English/Menu/Products-and-waste/Waste/Objectives-strategies-and-results/Future-priorities/

17 Swedish Environmental Protection Agency, A Strategy for Sustainable Waste Management, 2005

18 The DPSIR Framework, Peter Kristensen, National Environmental Research Institute, Denmark Department of Policy Analysis - European Topic Centre on Water, European Environment Agency. Paper presented at the 27-29 September 2004 workshop on a comprehensive / detailed assessment of the vulnerability of water resources to environmental change in Africa using river basin approach. UNEP Headquarters, Nairobi, Kenya

Within the DPSIR-model prevention activities and prevention indicators take a very specific place. DPSIR stands for[19]:

- Driving forces: which forces are present in the model, what is the fundamental reason for the dynamic of the problem: economic growth, social and cultural trends, demography, etc.
- Pressure: which pressure is executed by these on the environment: emissions, resource use, etc.
- State: what is the effect of this pressure on the state of the environment: emissions like greenhouse gases, acidification, eutrophication, etc.
- Impact: why should we be concerned about these changes in state: health risks, biodiversity, ecosystems, climate change, etc.
- Response: what can we do about it: policy measures, policy goals.

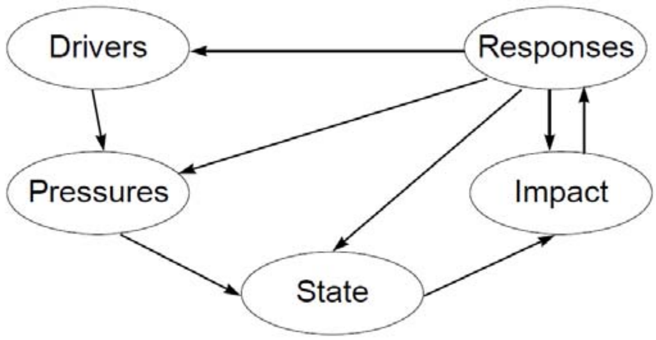

Figure 8: DPSIR model as included in the EEA technical report 25 (1999)

Response always influences driving forces (mentality change, market corrections), pressure (end-of-pipe measures, reduce waste quantity), state (sanitation) or impact (especially in evaluating impact, health studies, risk assessments). A response never stands on its own but is always related to other elements in the DPSIR model.

Prevention measures, which are deliberate policy interventions, are always response actions. They can be classified as

- Prevention actions R influencing the driving forces D: sustainable consumption patterns, instruments interacting on the market mechanisms, green public procurement …
- Prevention actions R influencing the pressure P: sustainable production methods, dematerialisation, resource use, avoiding emissions through reuse, ecodesign, qualitative prevention…
- Prevention actions R do not actually influence state S, unlike other waste management methods like waste collection or the clean up of fly tipping or dumpsites. However, prevention activities on driving force and pressure aim to change the state or the amount of waste to be managed.

[19] Edith Smeets and Rob Weterings, Technical report No 25 Environmental indicators: Typology and overview TNO Centre for European Environment Agency, 1999

- Qualitative prevention actions R without impact on the quantity of the waste generated can be considered as influencing the impact I of the generated waste. When avoiding the use of RoHS substances in electrical an electronic equipment, en impact on health of the people treating the WEEE can be prevented, although they keep treating the same amount of waste. This is of utmost importance when waste threats to be exported to countries with low waste treatment standards.
- Even when prevention actions R do not directly tackle state S or impact I, they can take them into account: awareness raising, generating sense-of-urgency …

3.2.2 The position of prevention in the material flow chain

A typical material flow can be distinguished by following life or use phases:

- extraction of raw materials
- production (through possible multiple sequential production phases)
- distribution and retailing
- use/consumption
- waste phase (treatment, recycling and disposal)
- end of waste phase (start of a new life cycle as recycled product)

Material flows following this basic structure, with intermediary steps depending on the nature of the material or product that is followed. JRC presents following example of a life cycle for a plastic part of a car.[20] All steps of extraction, production, retail, use, waste treatment and post-waste phase are included.

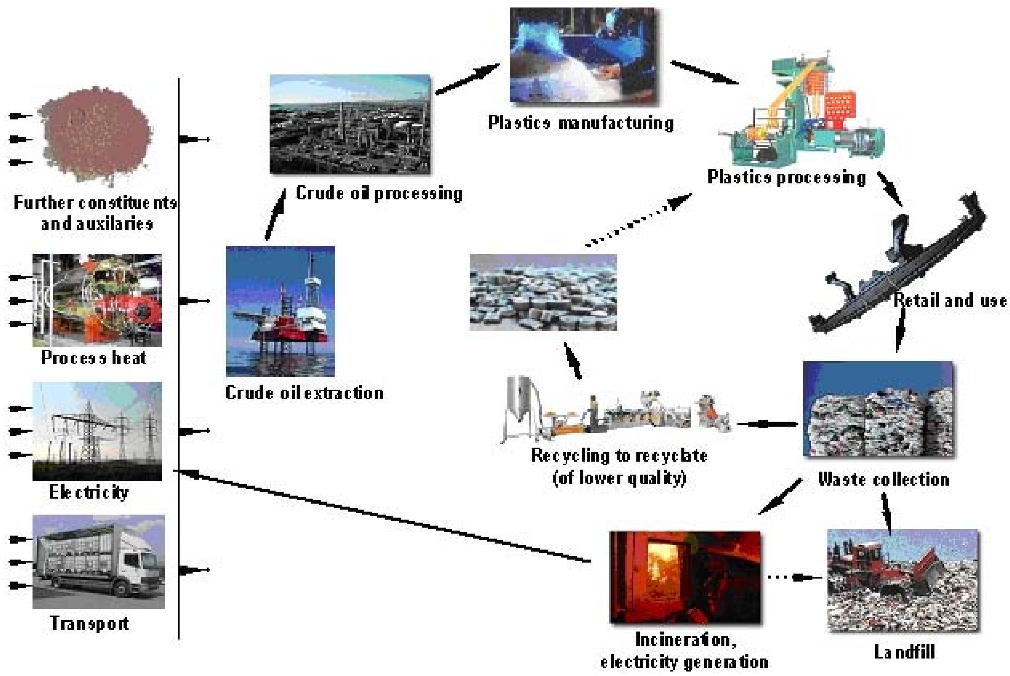

Figure 9: Material flow chain within the LCA of a plastic part in a car

[20] EUROPA-site on LCA tools, services and data, at http://lca.jrc.ec.europa.eu/lcainfohub/introduction.vm

However, above extraction, even before the physical life cycle on a material start, a preliminary “design” phase has to be taken into consideration, as in this phase the decisions are taken on the kind and amount of material that will be used.

Prevention occurs in all stages of the material flow chain:

3.2.2.1 Design

Qualitative and quantitative prevention through design for environment, design for product requiring less material input, less hazardous substances input less need for packaging, less need for frequent replacement or maintenance… At the same level but even earlier and more strategic level in the decision process prevention can take place when a service is chosen in stead of a physical product to serve the same purpose (dematerialisation), or when a strategic choice is made not to develop a certain product or not to develop a certain market.

3.2.2.2 Extraction

Prevention measures focus on the efficiency and the environmental impact of the extraction process. The waste generated through extraction processed is often a multiple of the end-of-life waste of the final product.

FIGURE 10 MATERIAL FLOW ACCOUNT OF THE NETHERLANDS

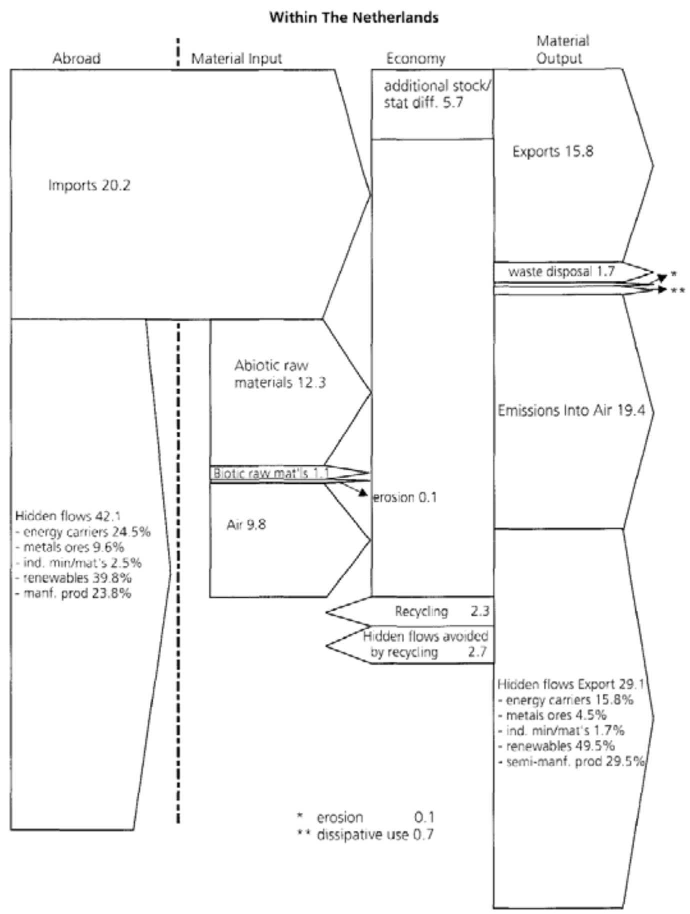

Figure 10: Material flow account of The Netherlands showing the impact of hidden flows.

The historically important study "Resource flow, the material basis of industrial economies"[21] of April 1997 points at the quantity of these 'hidden flows' which are associated with extractive activities, harvesting of crops, and infrastructure development. The material flow is described as hidden flow because it often remains in the country of origin and is not visible for the user of the material after import. The study points out that 55 to 75 percent of the total material requirement (TMR) of an industrial economy arise from hidden flows. Waste prevention in the extraction phase increases the balance between usable extracted material and waste from the extraction. It deserves discussing if hidden flows avoided through recycling are to be considered as prevention in the extraction phase.

3.2.2.3 Production

A large group of prevention actions focus on the production conditions of the material, avoiding pre-consumer production waste. Often they include technical measures to enhance the production processes and the resource efficiency. Through EPR schemes post consumer waste characteristics can become an important driving force for adapted production processes.

Because of sometimes long and complicated production chains the distinction between production and (industrial) consumption processes can be indefinite.

3.2.2.4 Distribution and retailing

Packaging waste

Prevention actions focus largely on primary, secondary and tertiary packaging. The essential requirements in annex II of the Packaging and Packaging Waste Directive[22] include the following provisions, related to qualitative and quantitative prevention:

- *Packaging shall be so manufactured that the packaging volume and weight be limited to the minimum adequate amount to maintain the necessary level of safety, hygiene and acceptance for the packed product and for the consumer.*
- *Packaging shall be designed, produced and commercialized in such a way as to permit its reuse or recovery, including recycling, and to minimize its impact on the environment when packaging waste or residues from packaging waste management operations are disposed of.*
- *Packaging shall be so manufactured that the presence of noxious and other hazardous substances and materials as constituents of the packaging material or of any of the packaging components is minimized with regard to their presence in emissions, ash or leachate when packaging or residues from management operations or packaging waste are incinerated or landfilled.*

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[21] Albert Adriaanse, Stefan Bringezu, Allen Hammond, Yuichi Moriguchi, Eric Rodenburg, Donald Rogich, Helmut Schutz. Resource Flows: The Material Basis Of Industrial Economies, World Resources Institute Washington D.C U.S.A., Wuppertal Institute Wuppertal Federal Republic of Germany, VROM Ministry of Housing, Spatial Planning and Environment The Hague, Netherlands, National Institute for Environmental Studies Tsukuba Japan, April 1997

[22] European Parliament and Council Directive 94/62/EC of 20 December 1994 on packaging and packaging waste

Prevention initiatives can be identified in[23]:

- Development of awareness raising and implementation support for the essential requirements in an approach of competent authorities participating in this thinking process on the packaging strategy of companies.
- A database of good examples or a list of best-in-class, to identify models that could be followed, and also to identify the product lines with the largest spread between best and worst performance as priority topics.
- Awareness raising on the cost reductions that can be realised through applying the Essential Requirements and packaging waste prevention[24].
- Possible waste-less or waste reduced distribution options, like self dispensing.
- Effective inspection on the requested qualitative prevention and the presence or absence of hazardous substances in packaging and packaging waste.
- Making the distribution sector co-responsible on achieving the goals of the Essential Requirements.

Other prevention actions

Next to the issue of packaging waste, other waste prevention initiatives directly refer to the distribution sector. They include measurements to avoid losses or damage in the manipulation of the goods, or losses through overstock of e.g. perishable goods that have to be disposed of because they cannot be sold any more.

Frame 2: Food waste prevention

Unlike the efforts taken to reduce packaging waste, prevention measures that address other waste streams are scarcer in the distribution phase. Important waste streams in the retail sector, next to packaging waste, are food waste and hazardous waste (lighting, electric and electronic equipment, waste oil and batteries…).

With regard to food waste, retailers can aim at reducing their own food waste as well as food waste on the consumer side. In the UK, over 40 major retailers, brand owners, manufacturers and suppliers have signed the Courtauld Commitment launched in July 2005. The participants have committed to reduce both post-consumer packaging and post-consumer food waste through innovative packaging and optimal choice of volume of the product, in-store guidance and a consumer campaign (Love Food Hate Waste).[25]

The retail chain Albert Heijn recently presented its food waste action program on the European Biowaste Forum (16-17 February – Brussels). With regard to food waste on the retailer side, the following actions are implemented:

[23] ARCADIS for DG ENV, A Survey on compliance with the Essential Requirements in the Member States (ENV.G.4/ETU/2008/0088r), Final report, 2009 - unpublished

[24] MAMBO, software package of OVAM to map hidden costs of waste. http://www.ovam.be/jahia/-Jahia/pid/101?lang=null

[25] Courtauld Commitment (Phase 1: 2005-2010) – Case studies, WRAP, 2009.

- Monitoring: a team of waste specialists monitors daily the sales of (most fresh) products. These specialists help to reduce the waste amounts of low-performing products;
- Logistics: smart logistic chain guaranteeing that products that decrease in sales are supplied in smaller amounts;
- Supplier: for most products Albert Heijn has a standard service rate of 99%;
- Mark down products which are close to being wasted.

With regard to the consumer side, the goal is to:

- Improve the clarity and consistency of date labelling and storage guidance;
- Help consumers to know what they need to buy, and how much;
- Let consumers take full advantage of special offers by knowing how to manage the extra food offered through these promotions (e.g. recipes)
- Optimize packaging

The most important difficulty is that suppliers need to have enough stock to fulfil consumers' demand. But if demand suddenly drops, waste rises.

3.2.2.5 Use/consumption

Prevention in the use phase refers to:

- The consumer behaviour, decisions on purchase and on choice, the effects of marketing. Marketing is one of the driving forces for the release on new products - covering newly created needs - that finally will end up in the waste phase.
- The expected lifespan of a product or a tool, and the frequency of replacement purchases. Denise Young (2007)[26] states that for example Canadian appliance retirement patterns differ from those assumed in literature. Socio-economic factors related to appliance replacement play a role. She found that replacement patterns can be sensitive to household characteristics such as income, providing evidence that there may be scope for targeted policies aimed at inducing other replacement patterns. Pål Strandbakken (2005)[27] defines a central question: is long lifespan or quick product exchange beneficial for the environment? The basic assumption is that generally, it is environmentally advantageous to increase the life span of products. However, when considering household durables that consume substantial amounts of energy in the use (cars, refrigerators …), this is not always the case. At some point in such a product's life span it may be environmentally advantageous – from a total energy use perspective – to exchange the old product for a new one, even it is still operational and if waste could be avoided by extending its lifespan.
- The consumption of consumables when using an equipment (e.g. printer toner, car lubricant, batteries …)
- Waste generated in repair or maintenance operations.

[26] Denise Young, When do energy-efficient appliances generate energy savings? Some evidence from Canada. Department of Economics, University of Alberta, Edmonton, AB, Canada T6G 2H4, June 2007

[27] Pål Strandbakken Social Constraints to Eco Efficiency: Refrigerators and freezers, National Institute for Consumer Research, Norway ESA Conference; Torun, September 05.

3.2.2.6 Waste phase

Prevention initiatives in the waste phase are often difficult to discern from other waste management activities. By using a better recycling technique, the quantity of recycling residues can be diminished. OVAM, the Public Flemish Waste Agency, introduces acceptable levels of recycling residues in its legislation[28] in the frame of reduced waste disposal levies. For plastic waste recycling a recycling residue of 20% percentage by weight is acceptable for installations using plastic waste as a raw material for the production of new substances or products. 5% percentage by weight is acceptable for installations pretreating plastics for the production of raw materials. 8% recycling residue is acceptable for installations treating vegetable, fruit and garden waste by aerobic composting, while 5% is acceptable for anaerobic digestion. This illustrates that depending on the applied recycling technique other quantities of recycling residue could occur. However, changing from one recycling technique to another is not considered as a quantitative waste prevention on recycling residues, but merely as a quantitatively better performing recycling activity.

The distinction between prevention and recycling is worked out in paragraph 3.3.3.

3.2.2.7 End of waste phase

A major issue in end-of-waste phase prevention is related to qualitative prevention. How to avoid that recycled products contain hazardous substances that where included in the wastes that have been recycled.

The POPs Regulation[29] includes in its article 7 strict provisions on how POP containing waste materials are to be treated, in such a way as to ensure that the persistent organic pollutant content is destroyed or irreversibly transformed so that the remaining waste and releases do not exhibit the characteristics of persistent organic pollutants. This is qualitative prevention on the waste treatment residues and the eventually recycled products. [30]

The same concern is covered by the Animal By-products Regulation[31] where recycling is excluded for several animal by-products/wastes to avoid contamination of the food chain with hazardous substances or pathogens, and by several other instruments in the frame of waste legislation at European or local level.

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[28] Decreet van 2 juli 1981 betreffende de voorkoming en het beheer van afvalstoffen, Decree of the Flemish Government on waste prevention and treatment of 2 juli 1981

[29] Regulation (EC) No 850/2004 of the European Parliament and of the Council of 29 April 2004 on persistent organic pollutants and amending Directive 79/117/EEC

[30] ARCADIS, Werk- en knelpunten in de Vlaamse afvalstoffen- en milieuwetgeving in verhouding tot de Europese Verordening 850/2004 en oplijsting van POP-houdende afvalstromen, 2008, (Improvements and bottlenecks in the Flemish waste- and environmental legislation regarding EU Regulation 850/2004 and summary of POP containing waste streams.)

[31] Regulation (EC) No 1774/2002 of the European Parliament and of the Council of 3 October 2002 laying down health rules concerning animal by-products not intended for human consumption

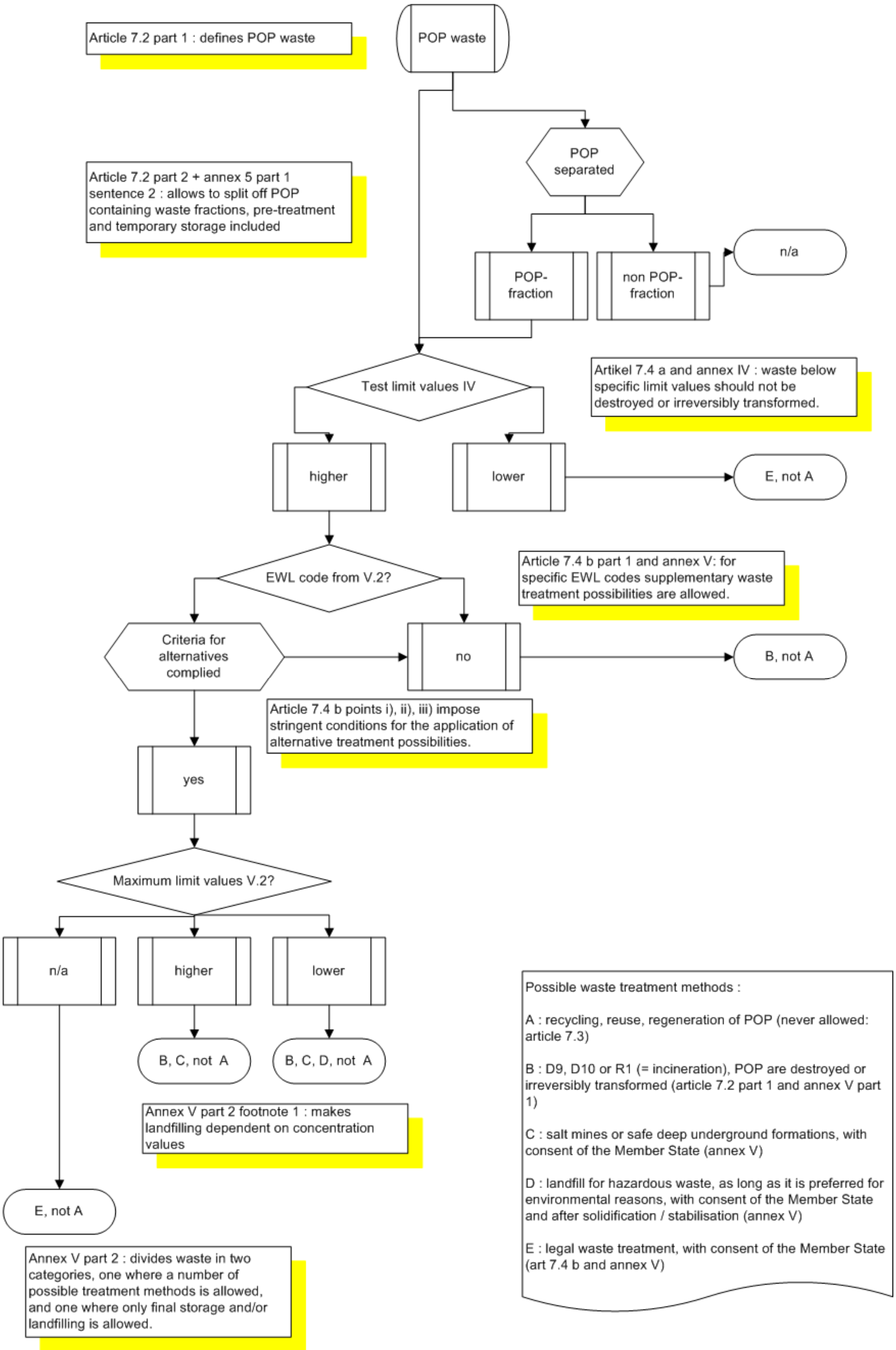

Figure 11: Qualitative prevention in the end-of-waste phase by the POP Directive

3.2.3 Waste prevention measures split up over instrumental characteristics

Waste prevention measures can be divided into regulatory or legal instruments, market-based or economic instruments, suasive or communication instruments and technical instruments.

Regulatory or legal instruments: "command and control" type of tool that regulates behaviour through penalties for parties who do not comply with the regulatory provisions. Types of regulatory instruments include standards, licensing and targets.

Market-based or economic instruments: tools that influence behaviour through economic signals rather than explicit directives. If they are well designed and implemented, they encourage individuals or firms to undertake prevention efforts that are in their own interests and that collectively meet policy goals. Two types of economic instruments can be distinguished:

- Instruments influencing prices, e.g. taxes and subsidies
- Instruments influencing quantities, e.g. tradable permit schemes

Economic instruments are either financial instruments (anything to do with transferring money) or instruments influencing the markets.

Suasive or communication instruments: tools that encourage change in behaviour through the provision of information, education, marketing, etc. Examples are public awareness campaigns, marketing of sustainable products, education of public purchasers, etc.

Technical instruments: we have added this fourth category to cover both ecodesign measures and reuse measures. These are more of an instrumental and technical nature, and can be incited by regulatory, economic or suasive instruments. Ecodesign and reuse can be considered as waste prevention "approaches" in stead of stand alone instruments. Ecodesign could be promoted by voluntary or binding standards, education, information, financial support for research, development and market penetration etc. For reuse Austria for example intends to support the development of a reuse brand, voluntary quality standards, the institution of a reuse expert platform and an internet platform for information exchange on reuse. One could call these initiatives either economic market development instruments or a mix of economic instruments and voluntary agreements and standards.

Sources:

- Per Mickwitz (2003) A Framework for Evaluating Environmental Policy Instruments Context and Key Concepts, Evaluation 9: 415-436
- Experience with Market-Based Environmental Policy Instruments - Discussion Paper 01–58 (2001) Robert N. Stavins, Resources for the Future, Washington DC, US, pp. 88
- Commission Green Paper of 28 March 2007 on market-based instruments for environment and related policy purpose [COM(2007) 140 final – Not published in the Official Journal]

3.3 General concepts of prevention

3.3.1 The relation between reuse and prevention

Reuse is not a waste treatment operation. The definition in the Waste Framework directive clearly states: *'re-use' means any operation by which products or components that are not waste are used again for the same purpose for which they were conceived.*[32] It is an operation to postpone the entry of the product in the post-consumer waste phase.

A concept closely related to reuse is remanufacturing. David Parker and Phil Butler[33] define remanufacturing as "A series of manufacturing steps acting on an end-of-life part or product in order to return it to like-new or better performance, with warranty to match." It is typically applied to complex manufactured products that possess significant embedded material, energy and labour resources, most of whose value can be recovered by suitable remediation techniques. From the perspective of the purchaser or user, the remanufactured product behaves like new and is backed up by an appropriate warranty from the seller or remanufacturer.

The same authors make a distinction on following types of reuse:

- Straight reuse, possibly by someone else, possibly in a different way.
- Refurbishment – cleaning, lubricating or other improvement.
- Repair – rectifying a fault.
- Redeployment & cannibalisation – using working parts elsewhere.
- Remanufacturing; the only option that requires a full treatment process – like new manufacture – to guarantee the performance of the finished object.

Reuse (and remanufacturing) is different from recycling because it involves preserving the whole form of things. In contrast, recycling activities require the destruction of the product to its component materials so they can be reprocessed into new forms. These could be the same products (called closed loop recycling) or into new ones (open loop recycling). CEPI arguments correctly that a thin line between reuse and recycling can exist, as well as other thin lines throughout the whole waste treatment hierarchy.

Reuse is a form of waste prevention, at two different levels. It (temporarily) prevents that a material or product enters the waste phase, but moreover it prevents the quantity of products entering the waste phase, especially in a replacement market.

The production of new products (that at the end will become waste as well) can be postponed or diminished:

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[32] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, article 3 number 13.

[33] David Parker and Phil Butler, An Introduction to Remanufacturing Centre for Remanufacturing & Reuse and Envirowise, 2007

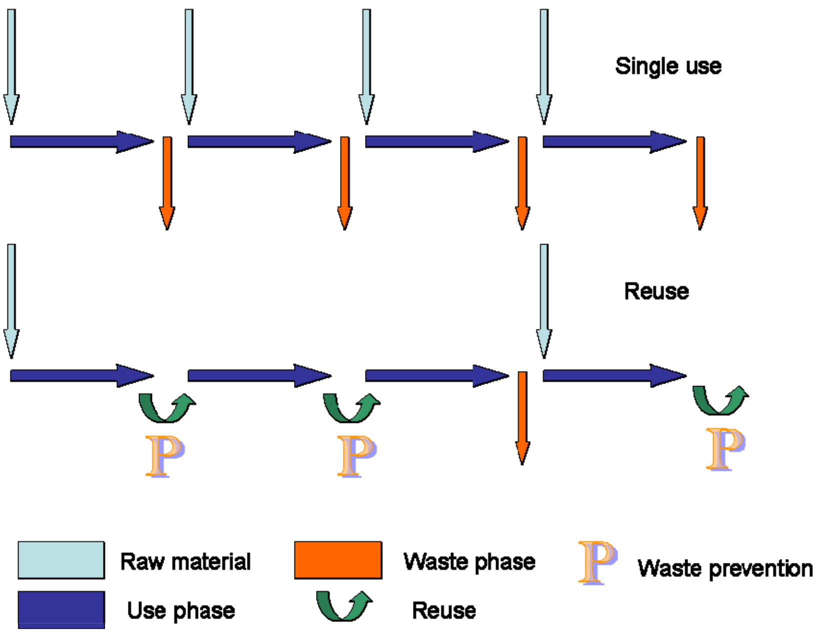


Figure 12: Reuse leads to prevention of waste

While reuse is a prevention activity, acting on non-wastes and situated on top of the waste treatment hierarchy[34], preparing for reuse is not. It is an action on waste or on products that have already entered the waste phase, to lift them again out of this phase and prolong their lifespan. Except for direct reuse, it could be argued that all categories mentioned by Parker and Butler can be considered ‘preparing for reuse’. They are situated at the second step of the waste treatment hierarchy. RREUSE argues however that the distinction between reuse and preparing for reuse is merely a legal issue, depending on the status of the product as waste or not. All activities as described by Parker and Butler can be executed on a non-waste as well as a waste, and therefore can be “reuse” or “preparing for reuse”. The OECD describes the concept of “preparing for reuse” as an artifice to cope with the (in their view) too broad definition of waste or of ‘discarding’. EEB agrees with the somehow superfluous distinction between “reuse” and “preparing for reuse” and proposes to answer the question by considering if there is a “returnable” scheme: if any, then cleaning, repairing… could be considered as reuse (prevention). If the processes listed by Parker and Butler are done within a value chain that doesn't have to do with waste (e.g. selling furniture to a second hand market that redeploys those) it could be considered reuse, if done so by a recycling company it could be considered preparation for reuse. This approach would solve more problems raised by other stakeholders on the difficulties with considering cleaning of returnable bottles as waste treatment, or when considering the distinction between “preparing for reuse” and multiple use within a normal life span of products.

An important issue when considering reuse and the desirability of reuse is the distinction between waste and second-hand. The question can be raised is if it is environmentally preferable that a second hand (reuse) application in a non-OECD country of old cars or EEE with limited life expectancy should be better than high quality recycling within the

[34] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, article 4.

European Union? Often low quality second-hand equipment is exported for which, even with great inventiveness to repair and reuse the equipment, it can be expected that it will not remain functional in tropical conditions. The capacity to treat the hazardous waste generated after disposal of the good is often limited or lacking in several countries of destination. RREUSE turns over the question and pus that a second-hand application in a non-OECD country of old cars or EEE with limited life expectancy still can be better than selling new products of low quality, with even worse life expectancy than good quality and tested reuse-products from the EU, with limited but longer life expectancy. Selling cheap and low quality new products (cars, computers, mobile phones) to developing countries has become normal practice while, at the same time, recycling potentially reusable products in Europe contributes more to the wasting of resources and energy and produces more environmental problems, waste and health impacts. RREUSE refers to examples, especially for computers and mobile phones, where immense social benefit was reached by making available cheap, but quality used appliances to people and institutions (e.g. schools), who could not afford new appliances. Complementing this argument EEB states that for reuse in developing countries, life expectancy should be addressed by design for upgradeability, and qualitative prevention by limiting hazardous contents in products.

Reuse through second-hand as a quantitative prevention measure should thus be combined with qualitative prevention of hazardous substances, especially when reuse takes place where no capacity for the treatment of hazardous waste exists.

OECD remarks that managing reuse requests a legal frame that is broader that the environmental legal frame, as buying and selling 'old' or 'used' material is an economic issue. Product warranties can be a part of the solution.

Another issue that can be raised is how to consider reuse of products that are not designed to be reused, or reuse of products for another goal than for which it has been developed. This is not in line with the definition of reuse in the Waste Framework Directive, which explicitly mentions: *"used again for the same purpose for which they were conceived".* EEB states that if a product is used even for a non intended initial purpose, it could be considered reuse, providing there are no other environmental consequences generated by this not initially intended use. RREUSE clarifies legally: There will be no discussion points on what is allowed as reuse. As long as a product is still a product (which has been prevented to become waste), anyone is allowed to put it to any use that it is fit for and that is not in conflict with other law (even growing flowers in a washing machine, if one likes to). "Preparing for reuse" must lead to a product which is fit for the purpose for which it was conceived, but still it is up to the new user what he/she wants to do with it.

3.3.2 Trade-off between qualitative and quantitative prevention

3.3.2.1 Balancing qualitative and quantitative prevention

By nature quantitative and quantitative prevention seem to be two different issues.

Quantitative waste prevention is the most straightforward concept. It aims at reducing the amount of generated waste. It prevents waste from being generated. The basic line of quantitative prevention is that waste is to be avoided because it is bad for the environment, for the resource depletion, for the limited capacity to treat the waste, and for the impact waste treatment has on air, water, soil, nuisance and other environmental domains.

Qualitative waste prevention is in its concept more related to fire prevention, illness prevention, disaster prevention… Prevention is defined by the UN-ISDR Secretariat as *"Activities to provide outright avoidance of the adverse impact of hazards and means to minimize related environmental, technological and biological disasters"*.[35] Applied on waste, qualitative prevention aims at preventing harmful impact on human health or nature of a waste - once generated - when it enters its waste treatment chain.

Both concepts can theoretically be balanced. When waste or waste treatment does not have any noxious impacts, why should its generation be prevented? Vice versa, when the generation of the waste is obviated, it cannot cause any environmental impact.

It should be kept in consideration that this balance is in a way asymmetric. Quantitative waste prevention is absolute. If a waste does not exist, it cannot cause any harm whatsoever. Qualitative waste prevention is more relative. If possible harm from a certain constituent is avoided, other harm could occur from other constituents or from the substituent. Qualitative prevention focuses at certain, well defined aims, like prevention of eco-toxicity or health risks, but could be neutral to other types of impacts, like energy use in the treatment installations, resource use or impact on land use, supplementary shipments, or even positive aspects like employment generation in the waste treatment industry. The over-all effect of waste generation/treatment plus qualitative prevention should be balanced against quantitative prevention or non-generation of waste.

CEPI argues that quantitative prevention is not as absolute as it might appear. Dematerialisation could have a significant environmental impact both in energy needs, climate change and in waste generation of the very material infrastructure and technology needed in producing the dematerialised services, and should be evaluated in the frame of a life cycle analysis. Furthermore substitution effects should be considered. ETC/SCP on the other hand states that provision of a service function instead of focusing only products is environmentally beneficial. Substituting products with services often leads to reduced environmental impacts throughout the life-cycle of the service (also provided by products).

Most respondents criticise the distinction made between quantitative and qualitative prevention. Qualitative prevention on specific hazardous substances leads to quantitative prevention of hazardous waste, but not to quantitative prevention of waste. Quantitative prevention should as well take care of the properties of the waste. Not all quantitative prevention is equally beneficial. CEPI explains that prevention of 1 tonne of used paper is not as important as prevention of 1 tonne of used plastics or electronics which may not be as important as prevention of 1 tonne of hazardous chemicals. To select the best way to perform quantitative prevention, qualitative characteristics are taken into account. RREUSE and EEB add that as a rule of thumb, the avoidance of waste is the best, even if waste treatment is of no harm. When waste is to be generated, non hazardous waste should be preferred, if other impacts are similar. When a balance between hazardous waste avoidance and other environmental impacts needs to be considered, approved LCA and environmental weighting of resources should be used. When waste or waste

[35] International Strategy for Disaster Reduction of the UN, Terminology: Basic terms of disaster risk reduction on http://www.unisdr.org/eng/library/lib-terminology-eng%20home.htm

treatment does not have any noxious impact, it does not imply that its generation should not be prevented. By definition, waste is a formerly useful material that can no longer be used, and as such, it is a lost resource. The energy to make this material available and to bring it into a useful form is also lost. To produce fewer products is quantitative prevention, and to produce the remaining products with less noxious impact is qualitative prevention. RREUSE states that both are needed, and none of the two can replace the other. Quantitative and qualitative waste prevention cannot be balanced. Only if you do not produce any more cars at all, you do not have to consider producing cars with less toxic components. Since this is not realistic, both concepts have to be applied on every product. Bottom line is; when qualitative prevention has been performed, this does not mean that quantitative prevention is no longer needed. Also, if quantitative prevention has been performed, this does not mean that qualitative prevention on the remaining or non-avoidable waste is not needed any more. Municipal Waste Europe concludes that the two are not exclusive but rather supportive of each other.

OECD states that qualitative prevention is easier to obtain, through product standards. As long as GDP growth is the main target of the current economic system, the consumption waste generation will increase due to the fact that most of the GDP growth is material-related. This means that quantitative waste prevention will remain the hardest challenge.

3.3.2.2 Incompatible prevention actions

Prevention actions cannot always be combined. They sometimes are incompatible. When promoting reuse as a prevention measure, to generate quantitative prevention on the total amount of packaging, it can be necessary to increase the quality and the wear-resistance of the individual packaging. It will request more material and will cause, once disposed of, a heavier waste product. Reuse as a quantitative waste prevention measure for a market segment has to be balanced against resource efficiency as a quantitative waste prevention measure at the level of the individual packaging. Consider a reusable packaging which can life three cycles. Reuse is in this case a sensible prevention activity, only if the packaging is less heavy than the combined weight of three single use packaging solutions. It however requests not only that the packaging is reusable, but that the packaging is effectively reused three or more times. The need to make a more wear-resistant packaging to perform quantitative waste prevention can make it necessary to add specific supplements or constituents. This can be in contradiction with a qualitative prevention policy that keeps the composition of the packaging as uniform and simple as possible to enhance high standard recycling.

3.3.2.3 The importance of Life Cycle Assessments

Frame 3: Life cycle analysis on reusable bottles

One of the most discussed topics is whether reusable bottles are better or worse than single-use bottles. Julian Carroll, Managing Director of EUROPEN the European Organization for Packaging and the Environment uniting companies with an economic interest in packaging and packaged products, calls this *"The continuing saga of arguments over reusable versus single use packaging"*.[36] This discussion is not merely a

[36] EUROPEN Brussels report 08/2004 on http://www.verpackungsrundschau.de/web/archiv/-bruessel/2004/brsl_08.html

discussion on waste generation and the effects of waste treatment, but it is expanded to material use and the impact of cleaning, collecting, refurbishing the packaging to make it ready for reuse. LCA widens the scope of the environmental question and is able to position qualitative or quantitative prevention and reuse among a multitude of environmental impacts, relating to more than the waste phase or the waste related environmental impact. Life Cycle Assessment (LCA) is a decision support tool that facilitates the comparison of alternative products and services that perform the same function (e.g. alternative packaging systems) from an environmental perspective.[37] An LCA typically quantifies the use of raw materials and energy and releases to air, water and land as well as assesses the associated impacts towards environmental concerns such as global warming and depletion of non-renewable resources from all steps from extraction of raw materials, through manufacture and conversion, distribution, use and disposal.

On behalf of EUROPEN URS performed a small study comparing LCA studies on the question which alternative is environmentally preferable: single use or reusable packaging.[38] The major conclusion is that the environmental benefits of reuse and recycling, or in this case multi and single trip packaging, are indistinguishable. In other words, whilst some studies show that reuse is preferable to recycling and others show the opposite, the reality is it is not possible to make a blanket conclusion owing to the need to take into account many factors that affect the outcomes of comparisons made. The review of the studies did not reveal a single answer to the question of whether reuse or recycling is environmentally preferable.

The study described in Frame 3 can be read as a criticism on the reliability of LCA studies, or even on the risk of biased results depending on the interest of who orders the study. However, it also shows that from an environmental perspective it is not assured that one option is better than the other, even if this one option includes quantitative prevention through reuse. It proves that an LCA perspective, although difficult to obtain, is necessary to judge on the balancing of prevention actions or of prevention versus recycling or other actions. This is in line with the Waste Framework Directive where article 4 includes the provision: *“When applying the waste hierarchy, Member States 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.”*

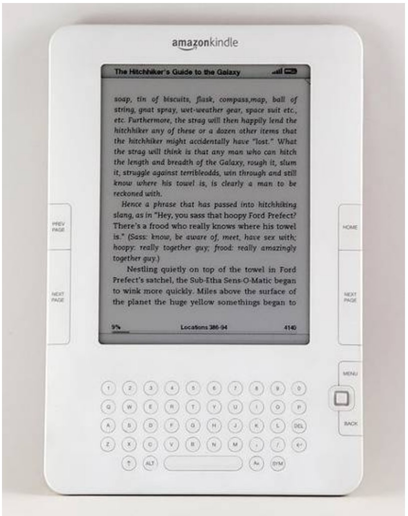
Several stakeholders consider this provision as a very important element in the way the waste treatment hierarchy should be applied. Municipal Waste Europe states a life cycle approach is to be used for the evaluation of the entire waste hierarchy. Prevention is not a goal in it self but rather an instrumental way of managing resources in a more sustainable way. Focussing on the impact in a life cycle approach will not entirely avoid discussions, but the difficult and impossible prioritising between different actions can only be reduced while concentrating on the common goal. CEPI warns for a “mechanical reading” of the hierarchy that it considers strange to reality, and would conflict with Article 4(3). The hierarchy should be read as a priority order of (multiple) actions, and not as a mutually exclusive list of actions with no interactions between them: for example “preparing for re-use” is likely to result in waste waters and other materials being

[37] Kirkpatrick, A review of LCA studies commissioned by EUROPEN, URS 2004
[38] Kirkpatrick, A review of LCA studies commissioned by EUROPEN, URS 2004

disposed of. Applying waste prevention should be done concentrating on the key environmental impacts and taking into account the whole life-cycle of products and materials. ETC/RWM states that life cycle thinking must be applied not only between the different levels of the hierarchy, but also within these levels. However, the problem is that the Waste Framework Directive does not set any common standards for how to make the life cycle thinking or the LCA or how to make the weighting of the different parameters in the LCA.

On the contrary RREUSE defends the straightforward nature of the hierarchy. The hierarchy states the preferable sequence of options unless other options are proven to give better results. Of course, it is necessary to look at the consequences for energy demand and resource distribution of reuse or other prevention activities, and, in some special cases, it might be better to avoid certain incompliant schemes. EEB thinks waste prevention should not be subordinated to LCA studies, as LCA do not integrate prevention criteria and specific dimensions (to be simple, by nature LCA assess what exists, not what has been prevented, or could be prevented). LCA studies and prevention programs are complementary approaches and not subordinated. It is thus difficult to use LCA to prove prevention should not be applied as the top action in the hierarchy. EEB further states that LCA analysis should be used where and when they add value, not as a pretext to delay or dilute prevention actions, both quantitative and qualitative.

Frame 4: LCA on dematerialised services, Amazon Kindle



CEPI states that it is not justified to blindly promote dematerialised services but to put them into the perspective of a life cycle assessment. A full life cycle perspective according to CEPI for example is not likely to show that electronic media do not have an environmental impact equal or greater to traditional. As an example, the life cycle data released by Amazon for the Kindle electronic reader is comparable to 22.5 individually bought paper books per year throughout the life span of the Kindle device. In other words, use of the immaterial Kindle is a waste prevention measure only when reading 23 or more individually bought books per year.

The Life Cycle Thinking (LCT) concept and quantitative tools such as Life Cycle Assessment (LCA) aim at providing an informed and science-based support to a more environmentally sustainable decision making in waste management. Life cycle thinking looks as the contribution over their life-time of products (goods and services) to various environmental impacts. Life Cycle Thinking considers upstream and downstream benefits and trade-offs. It seeks to identify environmental improvement opportunities at all stages across its life cycle: from raw material extraction and conversion, product manufacture, through distribution, use and eventual fate at the end-of-life stage. However waste prevention may start before these stages and includes design and market decisions. Life Cycle Thinking is considered complimentary to the waste hierarchy, helping to assess the benefits and trade-offs associated with the different options.

The draft ISPRA study “A technical guide to Life Cycle Thinking and Life Cycle Assessment in waste management for waste experts and LCA practitioners” applies LCT and LCA to highlight where waste prevention measures could pose a risk of actually increasing environmental impacts, rather than reducing them. For example, if taken too far, reduced packaging can result in the packaged product being damaged or lost more frequently and so more materials would be needed to deliver the same amount of packaged products. LCA is also considered useful for highlighting where waste re-use could pose a risk of actually increasing environmental impacts, rather than reducing them, e.g. through refurbishment or collection logistics.

Of particular importance is the choice of an appropriate ‘system boundary’ that describes what to include in or to exclude from the assessment.

3.3.2.4 An alternative hierarchy focussing on a life cycle perspective

When offering services, products, substances and materials to society following preferences could be followed in a life cycle perspective. EUROSTAT appraises this sequence of preferences that seem a good start from a material flow perspective. In the long term and in view of a cycling economy, we may even get rid of the narrow "waste concept" and will only talk about material flows:

1. Dematerialised services, without material loops
2. Services in closed material loops, where the material output forms the renewable input. Full cradle to cradle approach, with initial input and replenishment from sustainably managed renewable resources.
3. Services with input from renewable resources – a cyclic reuse phase – a waste disposal output
4. Services with input from non renewable resources – a cyclic reuse phase – a waste disposal output
5. Services with input from non reusable resources – a waste disposal output

- Resources include material, energy, land-use, biodiversity…
- Further detailing of this sequence can be made by considering a parameter of proximity, to avoid global haul of materials and products where it can be produced in local loops.

Prevention can be situated in several positions in this sequence. Quantitative waste and material prevention would evidently be a part of step 1. However, according to RREUSE it is also prominently present in stages 3 to 5 striving to minimize the waste disposal output that is not avoidable (and being 100% successful in level 2). RREUSE confuses in this approach 100% prevention with 100% recycling. Qualitative waste prevention could appear in all levels and it therefore not strictly linked to this sequence. Cradle to cradle approaches seem difficult to realise if any hazardous substances occur. Qualitative prevention appears an essential condition.

3.3.2.5 The position of qualitative prevention in the waste treatment hierarchy

Article 4 of the waste Framework Directive includes the waste treatment hierarchy. This is a priority order to be applied in waste legislation and policy in the Union and the Member States. As mentioned above, one can deviate from it if this is beneficial from a life cycle perspective. The categories of the hierarchy are[39]:

(a) prevention;

(b) preparing for re-use;

(c) recycling;

(d) other recovery, e.g. energy recovery; and

(e) disposal

Quantitative prevention is clearly to be attributed to step (a) of the hierarchy. And all activities like refurbishment, repair, redeployment or remanufacturing preparing for quantitative prevention clearly belong to step (b) of the hierarchy. They lead to the application of step (a) as reuse is an example of quantitative prevention.

Qualitative prevention however is more difficult to classify. It is prevention, thus it belongs to step (a), but qualitative prevention never stands on its own. Since the generation of the waste is not prevented, if will need to go to steps (b), (c), (d) or (e). Qualitative prevention can even focus on these steps, trying to avoid environmental impact when a waste is recycled, incinerated or landfilled. The waste treatment hierarchy should be read with care in this approach. It is better that a waste as such is recycled (c), instead of being adapted through qualitative prevention (a)[40] and further on landfilled (e).

When a treatment chain of a specific waste consists of two strongly joined operations, in casu (a)+(e), it should be looked as in global and be positioned at the lowest step in the chain, in casu (e). Although qualitative prevention occurs, the waste treatment solution remains less preferable than recycling (c).[41] In general we like to conclude that the waste treatment hierarchy is well fit to compare individual treatment options, but that it should be handled with care when waste treatment chains are at stake that combine different steps.

EEB remarks that the alternatives “qualitative prevention -> landfill/incineration” on the one hand and “no prevention -> recycling” on the other are artificial constructs, which should not be discussed on a general level, but only in relation to concrete problems at hand. Also RREUSE warns for general trade-offs in stead of a case-by-case evaluation on its environmental merits.

Vereniging afvalbedrijven rightly point to the lacking definition of quantitative and quantitative prevention, although definition 12a in the Waste Framework Directive can be considered quantitative prevention and definitions 12 b and 12 c qualitative prevention.

[39] Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on waste and repealing certain Directives, article 4.

[40] E.g. to cope with the acceptance criteria on a landfill

[41] This rule of thumb is applicable when qualitative prevention is connected to another treatment operation, but it is not applicable in case recycling is followed by landfilling of the recycling residue (c)+(e), compared with e.g. energy recovery (d)

To its opinion ‘qualitative waste prevention’ is to be discussed. If possible harm of a constituent is avoided, this is ‘harm prevention’ not ‘waste prevention’.

Frame 5: Effective inspection on qualitative prevention

Effective inspection on qualitative prevention and the presence or absence of hazardous substances in packaging and packaging waste is not easy to inspect on the field. Modern techniques have to be used. The usual way to inspect the heavy metal content of packaging is to collect packaging samples and to send them to a specialised laboratory that can perform atomic absorption spectroscopy or other analytical techniques. The analyses are often rather expensive and time consuming and only a limited set of samples is examined. The Belgian authority uses an X-ray fluorescence gun, which is less reliable but which can serve for a first selection of samples that need to be examined more in detail in the laboratory.

Figure 13: X-ray fluorescence gun

The advantage is that a larger quantity of packaging can be examined, in the field (e.g. in the super market) and with immediate result. General trends can be discovered and a better selection of samples leads to a higher efficiency compared with examining a random sample in the laboratory.

3.3.3 Recycling is not prevention

3.3.3.1 Prevention at the heart of waste management

As illustrated in Figure 14 waste prevention is closely connected to other waste and material/resource management measures, like raw materials consumption, sustainable production chains, sustainable consumption, reuse, recycling and disposal through safe sinks. However it should be taken into account that the definition of waste prevention does not include recycling, waste treatment or even resource prevention.

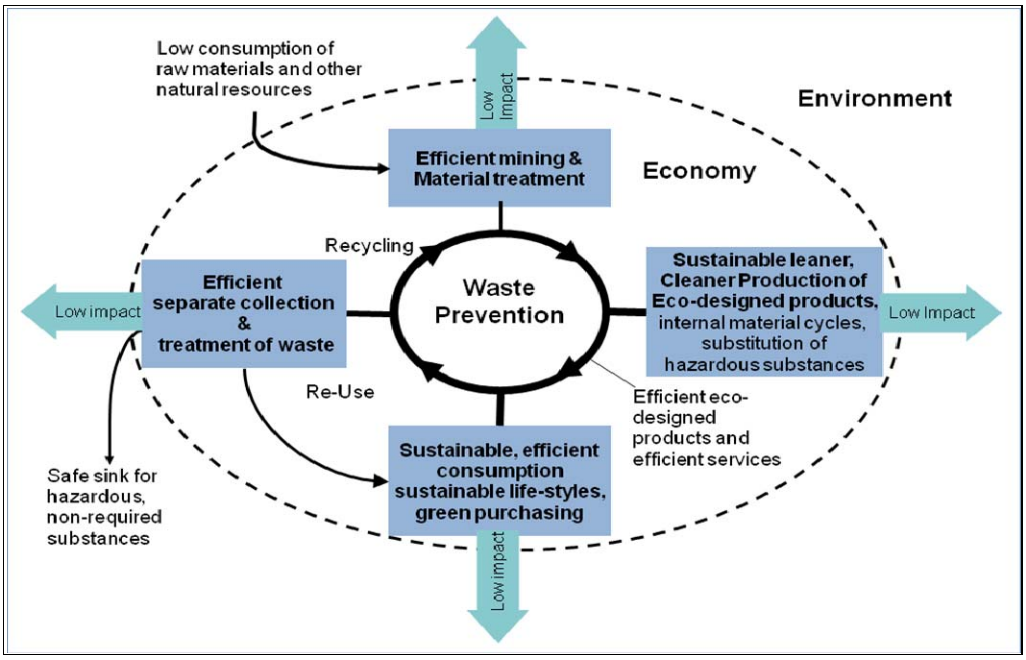


Figure 14: Waste Prevention at the heart of waste management

Recycling is the third step in the waste treatment hierarchy, prevention is the first step. Nevertheless between recycling and prevention some similarities and possible overlaps do occur. Both have the same finality, avoid or minimise negative impacts on human health and the environment.

EEB states that waste prevention should not be confused with resources efficiency. Waste prevention can contribute to resources efficiency, but need specific actions. It's not of secondary importance, a lot of prevention programs are diluted in recycling and other resources efficiency policies. The requirement of specific prevention plan and their evaluation in the Waste Framework Directive should stay a clear signal that prevention policies deserve dedicated attention and tools. Design for longevity, upgradeability is not the same as design for recycling.

3.3.3.2 Recycling leading to prevention

Recycling does not lead to quantitative prevention. It is not because waste is recycled or because at a certain stage it enters the end-of-waste phase, that it does not exist. Its process from waste to end-of-waste has its own environmental impact that should be accounted for. Nevertheless, recycling always leads to resource minimisation, because recycled waste replaces new raw materials. It does prevent waste at two levels, more or less comparable to the situation described for reuse, see paragraph 0. It prevents raw material from being entered in the production chain and at the end from becoming waste. Although the quantity of waste to be treated does not change, the quantity of material passing through the economy from raw material to waste is diminished. Furthermore at the early steps of the production chain, the generation of waste from extraction is avoided. Finally recycling prevents waste from being incinerated of landfilled, and thus prevents the environmental impact of incineration or landfilling (but replaces it by the environmental effects on the recycling process itself).

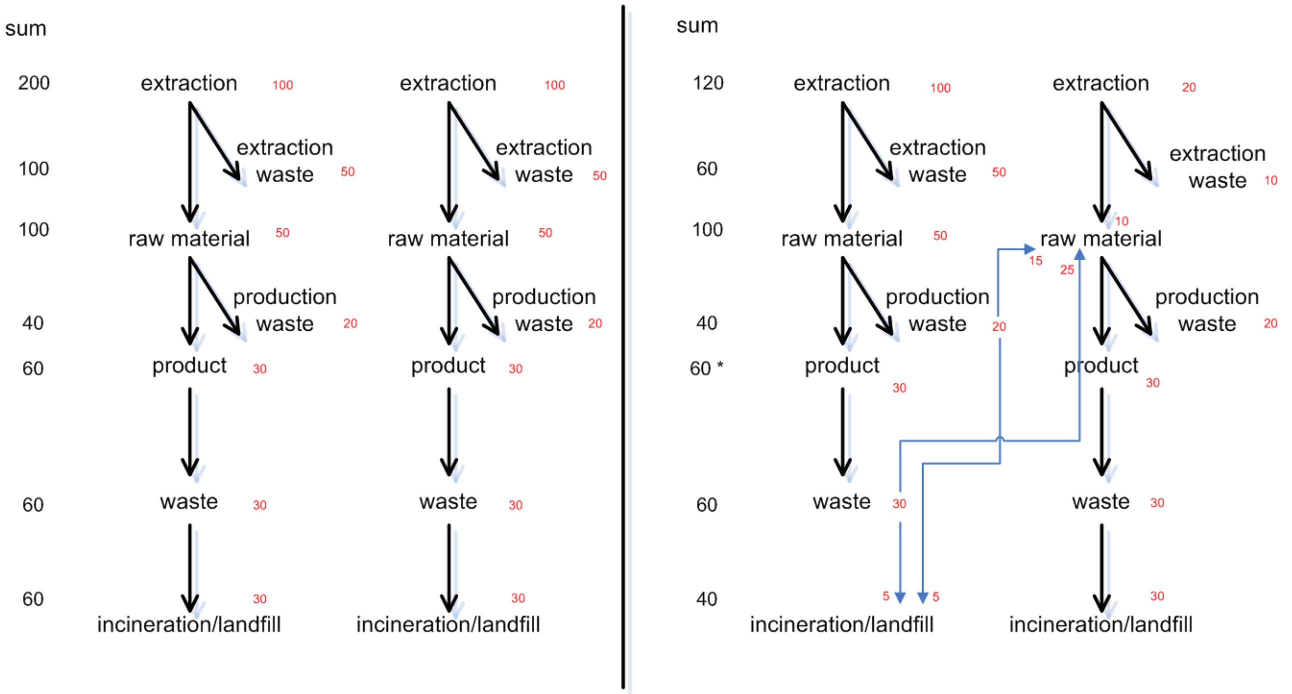


Figure 15: Calculated example for prevention through recycling

In the calculated example above a situation is compared where a product is produced, used, discarded and replaced by a new equivalent product that is produced, used and discarded. In the first scenario no recycling is taking place. All waste is landfilled or incinerated. In the second scenario recycling of the production waste and on the end-user waste takes place. No specific prevention actions take place.

When 100 ton material is extracted, this leads to 50 ton usable raw material and 50 ton extraction waste. In reality the ratio between extraction waste and raw material can be very different. Extraction waste usually is one of the more important hidden flows, both in quantity and in environmental impact. The largest prevention effect occurs when extraction (and extraction waste) is avoided through the use of recycled raw materials.

In both scenarios the same amount of raw material is used, the same amount of product is produced and the same amount of waste is generated, both in the pre-consumer and the post-consumer phase. No prevention occurs in these phases. It should however be remarked that the 60 tonnes product in scenario 1 are composed of new material (different atoms) while in scenario 2 in total only 40 tonnes of new material (different atoms) passes through the product phase of the material cycle. 20 tonnes of material in the second cycle was already present in the product in the first cycle.

It is this 40 tonnes that finally end up in incineration or landfill, unlike scenario 1 where 60 tonnes end up in landfill or incineration. Of course the result will even be better if the recycling does not stop after one cycle, as presented in this calculated example.

Bottom line: recycling leads to prevention of extraction waste, and to diminishing of landfill or incineration, but does not lead to prevention of pre- or postconsumer waste.

3.3.3.3 Prevention of non recyclable waste

Figure 15 shows in its second scenario a situation where a recycling society has not yet been reached. The recycling is incomplete and recycling residues or non recyclable waste still have to be landfilled/incinerated. It should be taken into account that landfilling or incineration of 10 tonnes of non recyclable pre-or post consumer waste in the first cycle leads to 20 tonnes extraction of needed resources, and to 10 tonnes treatment of extraction waste. Raw materials are often imported from third countries. Figure 16 shows an increasing import or ores from outside EU-27[42]. The extraction waste often is a hidden flow, treated in the country or origin, frequently outside the control of the importing country or the European Union. A recycling society therefore needs to tackle the problem of prevention of non recyclable wastes as a necessary complementary measure next to optimising recycling.

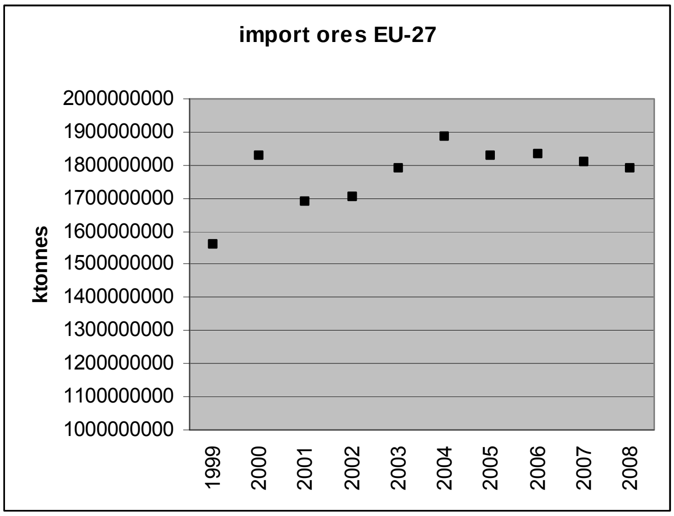


Figure 16: Import of ores in EU-27, data EUROSTAT-Comext

3.3.3.4 Complementarity and competition between prevention and recycling

Waste prevention and the other options of waste management are not competitors but they are mutually supportive, as described above. Nevertheless, it should be avoided that waste prevention is counteracted by the recycling or treatment industry benefitting from a larger quantity of waste products.

3.4 Taxonomy for waste prevention activities

Waste prevention activities or actions can be classified using four axes:

- The axis of quantitative or qualitative prevention effects. Actions of waste prevention can be divided on the results they generate.
- The axis of the place in the material flow where the prevention action takes place
- The axis of the policy cycle in which the prevention action interferes
- The axis of the nature of the policy instrument

Its taxonomy can therefore be seen as a four-dimensional matrix:

[42] COMEXT database for external trade, EUROSTAT, on http://epp.EUROSTAT.ec.europa.eu/newxtweb/

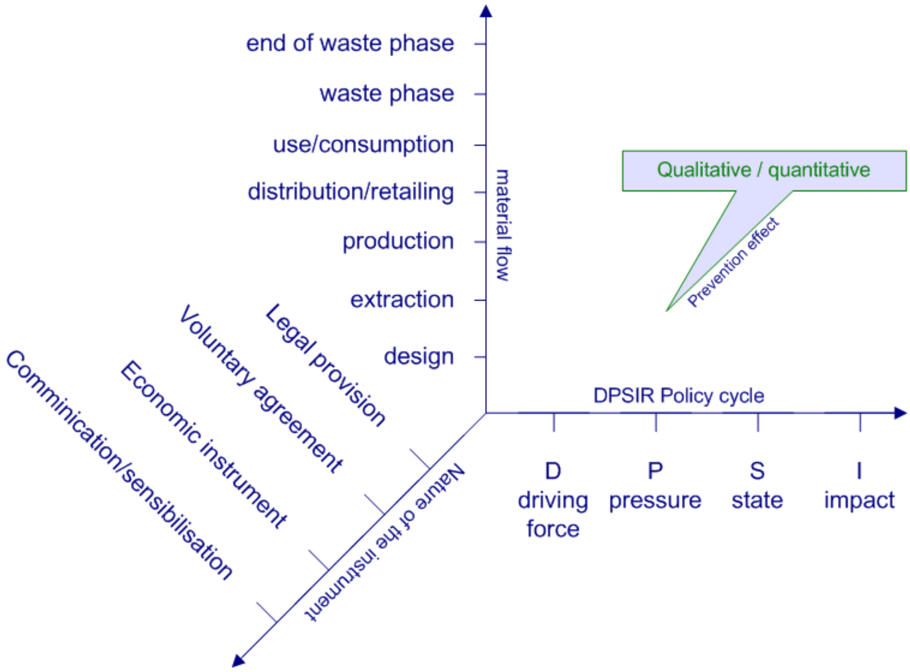


Figure 17 : Four dimensions of the waste prevention taxonomy

Each prevention activity can be classified using this taxonomy. E.g. the replacement of a product by a service, or dematerialisation, can be seen as a prevention activity with a clear quantitative effect, being realised in the design phase, and diminishing the state of generated waste. When dematerialisation is supported by a communication campaign to the industry, it is a communication/sensibilisation kind of prevention action.

It is a prevention activity that can shortly be classified as Pnsc1:

P: it is a prevention activity

n: its prevention effect is quantitative: n stands for qua**n**titative, l for qualitative

s: its acts on the state phase, the amount of waste; used codes are d p s i

c: it is a communication instrument c stands for communication, l for legal, e for economic, v for voluntary agreement

1: its material flow stage is 1 for design (2: extraction, 3: production…)

When people are to be convinced to quit the equipment and to use the dematerialised service, this awareness raising communication can be described as a prevention activity Pnpc5

n: all dematerialisation measures affect the quantity of waste generated

p: it acts on the driving force of consumer behaviour

c: it is communication

5: it takes place during use or consumption of the good or service.

These two simple examples show that often multiple effects are at stake, and that it is often not possible to attribute a prevention activity to one single dimension on the three axes. Because of changed behaviour in material flow stage 5, the design (1) and the distribution (4) have to be revised. It also shows that a prevention action often does not stand on its own. The dematerialisation of the equipment has to be accompanied by sensitation on consumer behaviour. It could also be accompanied by financial stimuli (e) or action of another nature.

The scope of this taxonomy is to offer a frame to classify prevention actions, and it will help further on in this study to define in which classes the most prevention activities take place and which classes are more neglected.

3.5 Visual map for waste prevention strategies

3.5.1 Detailed approach

In this chapter the different ways in which waste can be prevented are mapped out, reflecting the different kinds of activities and processes contributing to waste prevention.

Breaking the analysis of waste generation factors down into key elements of the supply chain is important as the influences on waste generation and waste properties are likely to be profoundly different at each stage, and hence the policy responses are likely to have to be individually tailored and targeted.

Waste policy actions can be visualised on the axes “phase in the life cycle”, and “kind of instrument”.

The life cycle contains the steps defined in paragraph 3.2.2 : design, extraction, production, distribution, consumption/use, waste, and end-of-waste

The instruments are defined in paragraph 3.2.3 : legal instruments, economic instruments, communication and other instruments, technical instruments

Each bullet in the scheme represents a prevention action. For each different prevention action a factsheet is developed to support the visual map. Moreover for each phase in the life cycle an umbrella factsheet is developed.

Following factsheets have been developed:

Table 8: Overview of instrumental and life cycle factsheets

instrumental factsheets	
1.	awareness and education
2.	ecodesign
3.	extended producer responsibility
4.	green public procurement
5.	labelling / certification
6.	marketing
7.	positive and negative financial stimuli
8.	prevention targets
9.	product standards
10.	reuse
11.	technology standards
12.	voluntary agreements
Lifecycle factsheets	
13.	lifecycle phase design
14.	lifecycle phase extraction
15.	lifecycle phase production
16.	lifecycle phase distribution
17.	lifecycle phase use
18.	lifecycle phase waste
19.	lifecycle phase end-of-waste

3.5.2 Visual map

	Design (13)	Extraction (14)	Production (15)	Distribution (16)	Consumption (17)	Waste (18)	End-of-waste (19)
Legal instruments	• Product standards (9) • Prevention targets (8) • Green public procurement (4)	• Technology standards (11) • Product standards (9) • Prevention targets (8)	• Technology standards (11) • Product standards (9) • Prevention targets (8)	• Prevention targets (8) • Market entries (2)	• Prevention targets (8)	• Prevention targets (8) • Technology standards (11)	• Product standards (end-of waste criteria) (9)
Economic instruments	• Positive/negative financial stimuli (7) • Extended producer responsibility (3)	• Positive/negative financial stimuli (7)	• Positive/negative financial stimuli (7)	• Extended producer responsibility (3) • Positive/negative financial stimuli (7)	• Positive/negative financial stimuli (7)	• Extended producer responsibility (3) • Positive/negative financial stimuli (7)	
Communication / other	• Labelling (5) • Awareness raising/education (1) • Voluntary agreements (12)	• Awareness raising/education (1) • Voluntary agreements (12)	• Awareness raising/ education (1) • Voluntary agreements (12)	• Awareness raising/ education (1) • Voluntary agreements (12)	• Labelling (3) • Awareness raising/education (1) • Marketing (6) • Voluntary agreements (12) • Green public procurement (4)	• Awareness raising/ education (1) • Voluntary agreements (12)	• Awareness raising/ education (1) • Green public procurement (4) • Marketing (6) • Voluntary agreements (12)
Technical instruments	• Ecodesign (2)	• Technology standards (11)	• Reuse (through remanufacturing) (10) • Technology standards (11)	Reuse (of packaging) (10)	• Reuse (reuse shops etc) (10)	• Reuse (reuse of parts) (10)	

3.5.3 Policy factsheets

The Waste Framework Directive gives a list of possible waste prevention measures in annex IV, i.e. measures that can affect the framework conditions related to the generation of waste, measures that can affect the design and production and distribution phase, and measures that can affect the consumption and use phase.

The key to success is certainly the use of instrument mixes, which use different strategies. Waste prevention measures need to be adapted to the waste stream they want to influence, and on the different target groups within the production, distribution and consumption phase. The following instruments are frequently used:

3.5.3.1 Awareness and education

Description

Goal:

To induce or sensitize

- the consumer towards the purchase of sustainable products, and
- the producer towards sustainable production, and
- the designer towards sustainable design.

Strategy:

- Education: at school, in technical training courses or work-based training
- Awareness raising: public awareness campaigns, specific awareness campaigns for well defined professional target groups

Awareness and education are communication tools. They can support both qualitative and quantitative prevention: they will direct consumers towards products with less packaging and less harmful packaging, they will direct producers and product designers towards sustainable products and sustainable production with limited amounts of hazardous substances, less packaging, less waste, higher reusability, etc.

It should be taken into account that awareness and education are not the same at each step of the life cycle, not targeting the same public, not mobilizing the same pedagogy and educational tools, varying from operator training and integration into professional competency, to informing consumers or educating children…

Examples:

- Education:
  - Sustainable development and resource efficiency as topics in school curriculum
  - Training on waste prevention procurement for purchasers
  - Training, guides, websites, etc. on sustainable production and design
- Awareness raising:
  - Websites, guides,… on sustainable consumption
  - Promotion and marketing campaigns (e.g. for eco-label)
  - Information and sensitization campaigns (television or radio spots, posters, etc.)
  - Contests & awards

Instruments

Awareness and education are ‘communication’ instruments that support every other (legal, technical or economic) instrument

Policy cycle

Awareness and education influence the attitude of the consumer, and thus the driving force of demand in a free market economy. It is a prevention action focussing on the D in the DPSIR model. When influencing the producer, it has its major impact on the pressure generated by the production process, and thus on P.

Point of impact in the life cycle of materials and products

Awareness and education have impact on every life phase from design over consumer phase to waste and end-of-waste phase. Awareness and education never stands on its own. It is a supportive and horizontal instrument joined to other policies.

Sources

- Flemish Waste Agency (2009) Analysis of innovative environmental policy instruments towards the realisation of environmentally responsible production and consumption, OVAM, Mechelen (Belgium), pp. 94 + attachments.
- Defra (2007) Household Waste Prevention Policy Side Research Programme, report prepared by Eunomia Research & Consulting, The Environment Council, Öko-Institut, TNO and Atlantic Consulting, pp. 412

Frame 6: Awareness raising on the Essential Requirement for Packaging and Packaging waste[43]

The collection of factual information on how the Essential Requirements are to be read and how they could affect their actual processes, products and packaging can be set up with a database of good examples or a list of best-in-class. This list can serve a double goal. To identify the best examples and present them as a model that could be followed, and also to identify the product lines with the largest spread or the largest distance between best and worst performance, as priority topic to better implement and enforce the Essential Requirements. This approach has been used by the UK competent authorities. Examples of good practice have been collected on the WRAP website.[44]

Frame 7: Awareness raising on the cost reductions that can be realised though prevention

Cost reduction has been identified as the most important driving force for companies to engage in prevention initiatives. But often manufacturers are aware of the visible costs for waste management, but not of the hidden costs for lost raw material, storage, manpower… OVAM, the public Flemish Waste Agency, has developed a software tool MAMBO to calculate these hidden costs in concrete situations.[45]

SMEs can be encouraged to optimize their waste management by giving them insight in the total costs related to waste production. To this end, the MAMBO methodology, developed by Ecolas (now ARCADIS Belgium), has been promoted by the Flemish

[43] ARCADIS for DG ENV, A Survey on compliance with the Essential Requirements in the Member States (ENV.G.4/ETU/2008/0088r), Final report, 2009 - unpublished

[44] http://www.wrap.org.uk/retail/tools_for_change/index.html and http://www.wrap.org.uk/retail/case_studies_research/index.html

[45] http://www.ovam.be/jahia/Jahia/pid/275

Waste Authority (OVAM) in the Flemish industry. MAMBO stands for “less waste, more company profits”. In previous projects it was demonstrated that the real waste cost for companies is up to 10 times higher than the out-of-pocket expenses for waste disposal. The “hidden costs” include resource and personnel costs. By making companies aware of their real waste cost, they are encouraged to implement waste minimisation measures that lead to financial benefits. Thus the competitiveness of companies will be increased by (1) the financial benefits, (2) increased awareness of resource efficiency and (3) compliance with environmental legislation.

3.5.3.2 Ecodesign

Description

Goal:

Conceptual and technical measures to reduce the environmental impact of products throughout their entire life cycle, including the reduction of the amount or changing the nature of raw material used.

Strategy:

Thinking process resulting in an optimised design in view of the ecologic impact of a product in its consecutive life cycle processes

Remarks:

- See also factsheet 'design phase', which includes more than the product oriented ecodesign, but as well commercial strategy development, market positioning, etc.

Examples:

(Taken over from 'design' factsheet)

- Minimisation of raw material used:
  - Reducing material inputs – dematerialisation, product downsizing
- Minimisation of waste during manufacturing
  - Redesign and production optimisation
  - Improving ecodesign through awareness raising on hidden costs and inefficient use of raw materials
  - Optimisation of packaging waste from components
- Distribution:
  - Reducing amount of packaging through optimisation of packaging design of the product
  - Designing packaging for re-use in multiple cycles and open or closed retour systems
- Use:
  - Improving product durability and wear-resistance
  - Designing to avoid waste during use stage, minimise needed consumables, minimise need for maintenance or repair
- End of life:
  - Design in accordance with the cradle-to-cradle philosophy
  - Reducing the amounts of hazardous substances, substitution of hazardous substances
  - Design for disassembly
  - Design for recycling e.g. single materials
  - Design for re-use

Instruments

Ecodesign in a technical instrument that can be supported by legal, economic and communication instruments focussing on the design life stage. See ‘design’ factsheet.

Policy cycle

Ecodesign aims at limiting the pressure caused by the materials in their lifecycle, and the impact these materials have on the environments. In the DPSIR cycle it affects P and I phases.

Point of impact in the life cycle of materials and products

Ecodesign is a clear instrument connected solely to the design phase of the lifecycle.

Sources

- M. Pullinger (2009) Reducing waste through promoting product ecodesign: a discussion paper, Scottish Government Social Research, Edinburgh, pp. 57
- M. Huber, R. Pamminger, W. Wimmer (2007) Ecodesign in a life cycle perspective. Waste prevention of products – a question of design and consumer patterns, Poster: 2nd Boku Waste Conference, Universität für Bodenkultur, Wien; 17.04.2007 - 19.04.2007; in: "*Waste matters. Integrating views*", Facultas.wuv, Wien (2007), ISBN: 978-3-7089-0060-5; S. 315 – 324

3.5.3.3 Extended producer responsibility

Description

Goal:

The Extended Producer Responsibility is an environmental policy approach in which a producer's responsibility for a product is extended to the consumer and post-consumer stage of a product's life cycle. By placing financial responsibility on producers for a products' end-of-life treatment and its environmental impacts, EPR policies are intended to push them to redesign their products for environment.

Strategy:

In an effective EPR scheme the true cost of waste management is internalized within the retail price and companies, because they are now financially responsible, will seek to reduce these costs to remain competitive. This in turn promotes eco-design of products. They will designed for optimal and therefore cheaper recycling (a.o. qualitative prevention), or to generate less waste in the post-consumer phase (quantitative prevention). In this way the producer avoids costs e.g. for treatment of waste or for treatment of hazardous substances in waste. While reducing waste management costs, materials use will be reduced and product reusability and recyclability will be enhanced.

The system often relies on a Producer Responsibility Organisation that takes over the individual responsibility of producers in a collective system.[46]

Examples:

EPR-programmes typically combine several EPR-bases policy instruments. Frequently an EPR programme is combined with collection or recycling targets. A take-back requirement can be complemented with the introduction of a deposit-refund system to give incentives to consumers to bring back products to an appropriate collection point. The manufacturers can also be required to provide information to recyclers about the content and the structure of their products while recyclers from their side can be forced to meet certain product standards.

EPR-instruments are:

- Legal and administrative instruments (voluntary or regulatory)
  - Take back obligation or duty of acceptance
  - Collective or individual producer responsibility schemes
  - Minimum recycled material content standard, product standard
  - Collection and recycling targets
  - Etc.
- Economic instruments
  - Advance disposal / recycling fees
  - Deposit-refund systems
  - Upstream tax / downstream subsidy

[46] Some sources argue that individual more than collective systems provide incentives to producers to design for environment. Collective systems might limit to initiatives that solely aim at recycling targets which do not, for the most part, consider ways and means to prevent what is occurring from their products. The drivers of ecodesign are strengthened when there is feedback on the total end-of-life costs to individual producers: namely collection, dismantling, re-use and high-levels of material recycling.

- Tradable (recycling) credits
- Etc.

- Informative instruments
  - Marking / labelling of products and components
  - Information provision to the consumers about producer responsibility and source separation of waste
  - Information provision to recyclers about the structure and substances used in products
  - Etc.
- Integrated product policy: IPP addresses the whole lifecycle of a product, which avoids shifting environmental problems from one lifecycle stage to another or one environmental medium to another.
  - Measures aimed at reducing and managing wastes generated by the consumption of products
  - Measures targeted at the innovation of cleaner products
  - Measures to create markets for cleaner products
  - Measures for transmitting information up and down the product chain
  - Measures that allocate responsibility for managing the environmental burdens of product systems.

Instruments

Extended Producer Responsibility systems can either be a legal instrument (specific wastes streams e.g. WEEE, ELV, packaging…) or a voluntary commitment. EPR is often classified as an economic instrument as well, because the producers become logistically and/or financially responsible for their products in the end-of-life phase, which brings about costs for collection, recycling, reuse… In the visual map this approach is selected.

Policy cycle

Extended producer responsibility directly targets at influencing the quantity and the nature of the waste generated and the pressure caused by it. In the DPSIR model it is a response action influencing the pressure P. EPR can contribute largely to qualitative waste prevention as it is often implemented for waste streams containing hazardous substances (WEEE, ELV …). Furthermore, EPR aims to push manufacturers to redesign their products to improve potential for reuse and recyclability and thus limiting the negative impact of products, waste and waste management.

Point of impact in the life cycle of materials and products

- Production phase: e.g.
  - Design for environment
  - Reduce material use
  - Enhance reuse
  - Enhance recyclability (≠ prevention)
- Distribution phase: e.g.

  - Reduction of volume/weight/hazardousness of packaging waste
- Use/consumption phase: e.g.
  - Sometimes visible, sometimes non visible supplementary costs for the treatment of a purchased product once it will end up in the waste phase: recycling contribution. (≠ prevention)
- Waste phase: e.g.
  - Source separated collection and reverse logistics (≠ prevention)
  - Information provision to the consumers about producer responsibility and source separation of waste
  - Design for reuse, modular design to extend product's life
  - Information provision to recyclers about the structure and substances used in products (≠ prevention)
  - Reduce hazardous components, e.g. WEEE, batteries, packaging
- End of waste phase: e.g.
  - Reduction/avoidance of hazardous substances in recycled materials

Sources

- Greenpeace international, Friends of the Earth and EEB, Extended Producer Responsibility – an examination of its impact on innovation and greening products, 2006, report prepared by Chris van Rossem, Naoko Tojo, Thomas Lindhqvist
- OECD, Working Group on Waste Prevention and Recycling, EPR Policies and Product Design: Economic Theory and Selected Case Studies, 2006
- http://www.oecd.org/document/19/0,3343,en_2649_34281_35158227_1_1_1_1,00.html
- Thorpe, B., Clean Production Action - How Producer Responsibility for Product Take-Back Can Promote Eco-Design, March 2008
- http://www.cleanproduction.org/Producer.International.Europe.php

3.5.3.4 Green public procurement

Description

Goal:

Authorities take account of environmental factors when buying products, services or works. With regard to waste prevention, they can purchase refillables, bulk products, second-hand goods, etc

Strategy:

Green public procurement can have the following impact:

- Achieve direct environmental benefits
- Help drive the market for greener products and services
- Set an example for corporate and private consumers

Examples:

- Direct selection and procurement of goods and services on the market
- Green conditions in technical specifications for constructions etc…

Instruments

Green public procurement needs support from communication instruments, such as:

- Awareness raising / education
- Labelling / certification

Policy cycle

Green public procurement directly influences the D driving force in the DPSIR model, as it changes the market conditions for green an non green suppliers, both direct through the volume of the public purchases and indirect through the example given to private purchasers.

Point of impact in the life cycle of materials and products

Green public procurement has impact on most life phases of a product:

- By setting technical requirements for product purchase (extraction, production and end-of-waste phase)
- By setting the good example for consumers (distribution, consumption phase)

Sources

http://ec.europa.eu/environment/gpp/index

3.5.3.5 Labelling / certification

Description

Goal:

Guide consumers and purchasers towards sustainable products by providing environmental information or information about the impact of the product on the environment.

Strategy:

- Quality mark: this type of label offers the assurance and guarantee that an independent third party has confirmed that a product meets all criteria that, prior to the assessment, were established for that particular product. It communicates reliable, controllable, and precise information about the products to the consumer. Two types of quality marks may be distinguished:
  - Official quality mark, e.g. European Eco-label and Blue Angel label
  - Private, collective quality mark: e.g. Max Havelaar and FSC label
- Informative label: this label provides information on the environmental impact of a product, but it is not inspected by an independent third party. They often deal with only one environmental feature, e.g. energy consumption or recycling. In contrast to a quality mark, an informative label is often affixed to each product, irrespective of how that product will act upon the environment (e.g. energy label), while a quality mark are only affixed to products that satisfy a given set of environmental conditions.
- Environmental Product Declaration (EPD): this declaration provides in standardised form quantified environmental information (e.g; CO_2 or NO_x emissions) based on the products' life-cycle. No assessment is made about the degree to which the product itself is eco-friendly; instead, the quantified information can be used by a potential buyer to formulate his or her own assessment, or to be entered into an LCA. EPDs are being inspected and approved by an independent third party. In contrast to labels, EPDs contain primarily information relevant to the businesses in the product chain (business-to-business), while labels are designed to address the end-users.

Labels help to prove qualitative prevention on hazardous substances, but have no impact on quantitative prevention.

Examples:

- Quality mark:
  - Official quality mark, e.g. European Eco-label, Blue Angel label, Environmental control, European bio label…
  - Private, collective quality mark: Max Havelaar, FSC, Nature Plus (building materials), Rainforest Alliance (coffee, bananas, cocoa, flowers…), MSC, Energy Star…
- Informative label: European energy-label in the white goods sector, Green Point, recycling logo, ecotax logo, wash-right logo (laundry products)…
- Environmental Product Declaration: EPDs are available for office chairs, windmills, construction materials, paper products…

Instruments

Labels are a communication instrument. They support other instruments, such as green public procurement or awareness raising / education.

Policy cycle

Labels influence the attitude of the consumer by providing information. As such, they affect the driving force of demand in a free market economy. It is a prevention action focussing on the D in the DPSIR model.

Point of impact in the life cycle of materials and products

The main point of impact is the user phase, as the user (consumers as well as purchasers) is the target group for providing environmental information. But it also has influence on the distribution phase, because the distribution sector should be the one providing products with labels (supported by the producer) and making them visible. Often labels are connected to the packaging of a product.

Sources

- Flemish Waste Agency (2009) Analysis of innovative environmental policy instruments towards the realisation of environmentally responsible production and consumption, OVAM, Mechelen (Belgium), pp. 94 + attachments.

3.5.3.6 Marketing

Description

Goal:

Induce or sensitize the consumer towards the purchase of sustainable products, such as refillables, bulk products, second-hand goods, etc.

Strategy:

- Marketing, publicity and awareness raising outside the store (advertising flyers, TV spots, internet, etc.)
- Marketing, publicity and lead system inside the store (banners, displays, wobblers, etc.) Choice editing and other distribution strategies.
- Negative marketing, limiting marketing as a means to limit consumption and waste generation.

Examples:

- Marketing outside the store:
  - Information and awareness raising campaigns conducted by the public authorities: e.g. campaign for the European Ecolabel “European Flower Week”
  - Information and awareness raising campaigns conducted by consumer organisations and other NGOs: e.g. RREUSE campaign Waste Watchers, the first European waste reduction campaign focusing on re-use, within the scope of the EU LIFE+ week for waste reduction 2009
  - Publicity and marketing by the distribution sector: e.g. advertising campaigns conducted by re-use stores.
- In-store marketing:
  - Point of Sales (POS) Marketing: not the product is marked, but the store itself is used for marketing of the product(s): on the floor, on the tags, on the shelves, to the ceiling, etc. In this way, it is avoided to use packaging as marketing instrument.
  - Label(s) on the product(s), increased shelf visibility of well performing products
- Limiting marketing
  - Ethical codes for marketing companies
  - Legislation on marketing

Instruments

Marketing is a ‘social’ or ‘information’ instrument. It is used to support other instruments, such as economic instruments.

Related instruments are:

- Awareness raising / education
- Labelling / certification

Policy cycle

Marketing influences the attitude of the consumer, and thus the driving force of demand in a free market economy. It is a prevention action focussing on the D in the DPSIR model.

Point of impact in the life cycle of materials and products

The main point of impact is the user phase, as the user is the target group for marketing. But it also has influence on the distribution phase, because the distribution sector is often the actor making the marketing effort, supported by the producer.

Sources

- Flemish Waste Agency (2009) Analysis of innovative environmental policy instruments towards the realisation of environmentally responsible production and consumption, OVAM, Mechelen (Belgium), pp. 94 + attachments.

3.5.3.7 Positive and negative financial stimuli

Description

Goal:

In general, the main purposes of economic instruments that can induce waste prevention are to achieve a more efficient use of resources and the reduction of waste (steering effect) and cost coverage (revenue raising effect).

Strategy:

The use of market based instruments can be effective as often the true cost of waste or resource use is not allocated to the causer / originator. Positive financial stimuli predominantly aim at green resource efficient production and cleaner products.

Examples:

- Taxes and charges on aggregates / virgin material: The objective of the charge is to promote efficient resource allocation by altering the relative prices between virgin materials and other input factors. Increased relative cost of primary material extraction and use can therefore contribute to the reduction of waste generation and to reuse of secondary raw materials. Similar effects can be obtained by subsidy removal for mining or extraction activities.
- Taxes on products: charges or taxes on product and / or on its packaging, based upon the types of raw materials used, their harmfulness to the environment, recyclability, difficulty of disposal, etc. These taxes have a direct steering effect on consumption behaviour and indirectly on production.
- Taxes and charges on waste: The principal purpose of these taxes can be the promotion of recycling and recovery (increase relative price of disposal through landfilling or incineration) or consideration of cost coverage (fees or charges for household waste). These measures have a potential preventive side-effect as they comprise incentives to reduce waste generation.
- Incentives (grants, subsidies, tax deductions or exemptions): These incentives mostly cover a wide range of activities such as support for cleaner production technologies and natural resources management or more general schemes to support the national environmental policy (particularly the environmental funds of Eastern Europe).

Financial stimuli can be product-, process- or consumer oriented

- Product oriented: e.g. ecodesign through raw material taxes
- Process oriented: e.g. grants for cleaner production
- Consumer oriented: e.g. variable VAT on products.

Instruments

Positive and negative financial stimuli are economic (and often market based) instruments.

Supporting instruments are amongst others:

- Taxes and charges on aggregates / virgin material
  - Forest resources charges
  - Mining charges

- Etc.

- Taxes and charges on products
  - Disposable plastic bags
  - Disposable plastic kitchenware
  - Plastic plates, sheets, strips, tape, foil and other flat shapes, even in rolls, for household use
  - Batteries.
  - Disposable cameras
  - Packages of certain types of glue, ink or solvent for professional use
  - Reduced tax on the sale of reused goods
  - Differentiated tax non-reusable and reusable beverage packaging
  - lower VAT on ecolabelled products
  - Etc.
- Taxes on waste:
  - Landfill and incineration charges and taxes
  - Differential charging for household waste (user fees, pay as you throw)
  - Etc.
- Incentives
  - Incentives for manufacturing:
    - Tax credits (innovation, R&D, environmental investments)[47]
    - Accelerated depreciation for environmental investments
    - Funding prevention programs (e.g. grants for research into waste prevention in SMEs)
    - EPA and Enterprise Ireland Grant Programmes (e.g. STRIVE: Cleaner Greener production Programme, Environmentally Superior Products): both initiatives aim at stimulating widespread uptake of environmental management systems, ecodesign, cleaner production
    - Subsidised advice (often free)
  - Other incentives
    - Tax exemptions for reuse and repair centres
    - Deposit-refund schemes: stimulating and improve chances of reuse

Policy cycle

In the DPSIR model, financial stimuli are mainly a response action influencing the pressure P, executed on the environment. This preventive effect can be seen both in qualitative and quantitative terms: more efficient resource use through raw material taxes or grants for technological innovation can result in an effect on waste quantities, while

[47] Tax deductions (and other subsidies) may be economically justified in some cases, for example when positive externalities appear (e.g. environmental innovation projects). However, no subsidies or deductions should be granted to actions that are anyway compulsory to undertake (eligible projects should be those measures going beyond legal obligations). Positive element is that tax deductions constitute a form of public support that distorts the market the least, since is not the Public Authority that decides what specific projects to subsidise, but companies that decide whether to make use or not of the tax deduction, and this is automatically granted if the application qualifies. It is sometimes argued that tax deductions also entail (at least in principle) less administrative costs than subsidies, both for public administrations and for companies.

higher VAT rates for hazardous products can shift consumption to lower impact products. The latter can also be regarded as changing consumer behaviour, which is a response to the driving forces D of the model.

Point of impact in the life cycle of materials and products

- Extraction phase: e.g.
  - Tax / charges on primary raw material
- Production phase: e.g.
  - Tax / charges on primary raw material
  - Product taxes
  - Tax credits (environmental investments, R&D, waste prevention initiatives in SMEs)
- Distribution phase: e.g.
  - Tax on shopping bags
  - Taxes on packaging: avoid intermediate packaging
  - Deposit-refund systems
- Use/consumption phase: e.g.
  - Product taxes
  - Deposit-refund systems
- Waste phase: e.g.
  - Landfill and incineration taxes and charges
  - Differentiated tax household waste
- End of waste phase: e.g.
  - Tax / charges on primary raw material, stimulation the use of secondary raw material

Sources

- Environmental Protection Agency (EPA Ireland), Assessment and Development of a Waste Prevention Framework for Ireland, synthesis report, 2004
- ETC/RWM working paper 2006/1 - Economic instruments to promote material resource efficiency, February 2006
- Ministry of housing, spatial planning and the environment (VROM, the Netherlands), factsheet waste prevention, 2001
- OECD, Working Party on Pollution Prevention and Control – strategic waste prevention, OECD Reference Manual, 2000
- OECD, Taxation, Innovation and the Environment – The Spanish Case, 2008
- OECD/EEA database on instruments used for environmental policy and natural resources management: http://www2.oecd.org/ecoinst/queries/index.htm

3.5.3.8 Prevention targets

Description

Goal:

Reaching predefined quantitative targets that are better and more sustainable than the actual situation.

Strategy:

Prevention targets are a quantitative instrument. This means that they are inextricably bound up with tools to measure prevention. This can be straightforward quantitative prevention, where the amount of prevented waste is measures, or qualitative prevention, where the amount of specific pollutants or composing elements of a waste can be measures, or instrumental, where the success and the application of a specific instrument is measured.

Prevention targets need to be chosen in a way not to slow down the front-running actors or Member States, not to discourage who lags behind but still incite all to better performances. For this reason targets have to be chosen in a considered way to avoid counter-productive effects.

Prevention targets can be imposed at the level of an individual company, a sector, a product, a region, a Member State or the total of the European Union.

Examples:

- The Waste Framework Directive aims in its article 9 c at: "by the end of 2014, the setting of waste prevention and decoupling objectives for 2020, based on best available practices including, if necessary, a revision of the indicators.
- The same Directive states in its article 29 that: Member States shall establish waste prevention programmes not later than 12 December 2013, and these shall set out waste prevention objectives. Member States shall determine appropriate specific qualitative or quantitative benchmarks for waste prevention measures adopted in order to monitor and assess the progress of the measures and may determine specific qualitative or quantitative targets and indicators.
- In Belgium and Portugal, companies responsible for packaging have to submit an individual prevention programme, in which targets have to be defined.
- Following types of targets can be set:
  - Reaching a degree of decoupling
  - Producing no more than a fixed quantity of a waste
  - Producing less waste expressed as a percentage of the production in a reference year
  - Maintaining a continued degree of diminishing waste generation year by year
  - Reaching a specified level of product safety or product composition
  - Reaching a level of application or coverage, specified for a well defined instrument (e.g. reaching a % of households, distributing a number of no-publicity stickers for letterboxes, inciting a % of the population of consumers to use reusable shopping bags etc…
  - Reaching a level of remanufactured goods for a certain product range e.g. ICT-products, toners…

Instruments

Prevention targets are regulating instruments, either legally imposed targets or agreed targets in a voluntary prevention scheme. They can be integrated in extended producer responsibility schemes offering an economic support for the instrument, and they need in any case to be supported by communication on the target value and the distance-to-target and by suasion instruments.

Policy cycle

Prevention targets have effect on quantitative prevention, and thus on the Pressure, and on qualitative prevention and this on the Impact state in the DPSIR model.

Point of impact in the life cycle of materials and products

The main point where prevention targets can effectively have impact on the life cycle is at the early start, in the design phase of a product. Through stimulating the instrument of reuse, prevention targets can as well have their impact on the distribution and consumption phases.

Sources

- A Survey on compliance with the Essential Requirements in the Member States, ARCADIS, 2009
- www.ivcie.be
- Directive 2008/98/EC of the European Parliament and of the Council of 19 November 2008 on Waste and repealing certain Directives

3.5.3.9 Product standards

Description

Goal:

Specification of requirements to be fulfilled by a product or group of products, to establish its fitness for purpose, in casu qualitative prevention or resource efficiency and quantitative prevention.

Examples:

- Limits / bans on the use of harmful substances (e.g. RoHS, REACH, POP, ODS, …)
- Product specific waste legislation : WEEE, ELV, Batteries
- Requirements regarding minimum volume / weight (e.g. packaging Essential Requirements)
- Requirements regarding quality of the product (e.g. end-of-waste criteria)
- Requirements regarding guarantee (e.g. product durability, remanufacturing)
- Requirements on labelling of the product (e.g. CE mark, ecolabel, …)
- End-of-waste criteria, included in the Waste Framework Directive.
- Etc.

Instruments

Product standards are mainly legal instruments, but sometimes also voluntary agreements or marketing instruments. They range from a list of recommendations issued by some private institution or interest group to legally binding regulations.

Supporting instruments are:

- Voluntary or mandatory labelling / certification
- Voluntary or mandatory green public procurement
- Extended producer responsibility
- Awareness raising / education
- Ecodesign

Policy cycle

Product standards directly influence the quantity and the nature of the waste generated and the pressure caused by it. In the DPSIR model it is a response action influencing the pressure P, or in case of qualitative prevention on hazardous substances in waste it influences the impact I of the waste.

Point of impact in the life cycle of materials and products

- Extraction phase: e.g.
  - Limits / bans on the use of certain substances or materials in the extraction process
- Production phase: e.g.
  - Use (e.g. %) of recycled materials, preventing extraction and extraction waste

- Ban in the use of substances, materials
- Distribution phase: e.g.
  - Reduction of volume/weight/hazardousness of packaging waste
- Use/consumption phase: e.g.
  - Product durability
- End of waste phase: e.g.
  - Reduction/avoidance of hazardous substances in recycled materials

Sources

CEN Guide 4:2008 - Guide for addressing environmental issues in product standards (adopted by the CEN Technical Board through resolution BT C065/2008)

Frame 8: Applying RoHS and REACH on products and substances

The RoHS Directive or the Directive 2002/95/EC of the European Parliament and of the Council of 27 January 2003 on the Restriction Of the use of certain Hazardous Substances in electrical and electronic equipment aims to ensure that, from 1 July 2006, new electrical and electronic equipment put on the market does not contain lead, mercury, cadmium, hexavalent chromium, polybrominated biphenyls (PBB) or polybrominated diphenyl ethers (PBDE). Its scope is to contribute to the protection of human health and the environmentally sound recovery and disposal of waste electrical and electronic equipment.

RoHS is thus more than a qualitative waste prevention Directive, although waste and its safe environmental treatment is explicitly mentioned in its objectives in article 1. But it aims as well to protect human health (without mentioning environment) throughout all life phases of equipment.

RoHS precedes REACH. Regulation 1907/2006/EC of the European Parliament and of the Council of 18 December 2006 concerning the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) has a much broader scope and aims at information sharing throughout the life cycle on the risks of a substance, and the restriction of use of certain more hazardous substances. Its scope is to ensure a high level of protection of human health and the environment, by covering a wide range of substances and mixtures, its manufacture, placing on the market or use of such substances on their own, in mixtures or in articles. Waste is explicitly excluded from the coverage of REACH. But nevertheless REACH has a beneficial effect on the qualitative prevention of waste when REACH-compliant products enter the waste phase.

3.5.3.10 Reuse

Description

Goal:

Reuse (temporarily) prevents that a material or product enters the waste phase, namely it postpones the entry of a product in the post-consumer waste phase. Moreover it reduces the quantity of products entering the waste phase, especially in a replacement market.

Strategy:

Two activities should be distinguished:

- Preparing for reuse (refurbishment, remanufacturing, etc.) is a waste treatment activity, and should therefore not be considered as a prevention activity. They are part of the second step in the waste treatment hierarchy.
- Reuse is a prevention activity.

Examples:

- Reuse: refillables, reusable pallets, reusable packaging, rechargeable batteries, second-hand cloths or equipment, reuse of plastic bags, etc.
- Preparing for reuse[48]:
  - Refurbishment – cleaning, lubricating or other improvement, e.g. preparing milk bottles for reuse
  - Repair – rectifying a fault, e.g. repairing electric or electronic equipment in a repair shop / second hand shop
  - Redeployment & cannibalisation – using working parts elsewhere, e.g. in a repair shop / second hand shop of
  - Remanufacturing

Instruments

Reuse is related with the following instruments:

- Ecodesign: design for reuse
- Product standards, e.g. Essential Requirements of the Packaging Directive, CEN standards or Member State legislation imposing a minimal number of rotations.
- Awareness raising / education: support reuse
- Labelling / certification e.g. RReuse label to guarantee well functioning and safe appliances, repair by certified employees according to specific procedures.

Policy cycle

Reuse influences the free markets both on the supply and demand side, and thus it interacts with a main driving force, D in the DPSIR model. It drives demand away from new products by offering a supply of more sustainable alternatives.

Point of impact in the life cycle of materials and products

[48] As mentioned in paragraph 3.3.1, preparing for reuse on non-wastes can be considered prevention.

Reuse mainly has impact on quantitative prevention in the production, distribution and consumer phase, because less post-consumer waste is generated.

In the production phase, remanufacturing (a preparing for reuse activity) may lead to higher reuse of spare parts recovered from older equipment.

In the distribution phase reuse is manifested in the reusable packaging alternatives.

In the consumer phase reuse can be found in second hand shops and repair-shops.

With regard to qualitative prevention, reuse might occasionally have a negative effect. Older products (e.g. electric and electronic equipments) tend to contain higher concentrations of hazardous substances or have a higher energy use. By reusing older equipment, the risks of emissions to the environment could be prolonged. By recycling the hazardous substances can either be removed, or they are diluted in the quantity of recycled material[49].

Sources

- David Parker and Phil Butler, An Introduction to Remanufacturing Centre for Remanufacturing & Reuse and Envirowise, 2007
- RREUSE position paper on the Commission's Communication Integrated Product Policy – Building on Environmental Life-Cycle Thinking

[49] E.g. Commission Decision 2009/292/EC establishing the conditions for a derogation for plastic crates and plastic pallets in relation to the heavy metal concentration levels

3.5.3.11 Technology standards

Description

Goal:

Using best available technology (BAT) to achieve a resource efficient extraction or production process.

Strategy:

With regard to waste, BAT requires to consider the following measures:

- the use of low-waste technology;
- the use of less hazardous substances;
- the furthering of recovery and recycling of substances generated and used in the process and of waste, where appropriate. *(no prevention policy)*

Examples:

More than 30 available BREFs (BAT Reference Documents) for a diverse range of sectors (textile, oil and gas, chemicals, pulp and paper, iron and steel, etc.)

Instruments

Technology standards are mainly legal instruments, but sometimes also voluntary agreements or marketing instruments. They range from a list of recommendations issued by some private institution or interest group to legally binding regulations.

Related instruments are:

- Ecodesign
- Extended producer responsibility
- Awareness raising / education
- Green public procurement
- Voluntary agreements

Policy cycle

Technology standards directly influence the quantity and the nature of the waste generated and the pressure caused by it. In the DPSIR model it is a response action influencing the pressure P, or in case of qualitative prevention on hazardous substances in waste it influences the impact I of the waste.

Point of impact in the life cycle of materials and products

Technology standards mainly have impact on the extraction and production phase, where they can result in both quantitative and qualitative waste prevention of industrial waste.

Sources

http://eippcb.jrc.es/reference

3.5.3.12 Voluntary agreements

Description

Goal:

Setting environmental objectives (e.g. waste prevention targets) in cooperation with the industry. The government may set preconditions to the result; a corrective mechanism may be foreseen in case the fixed objectives are not being met.

Strategy:

- Agreements between government and the industry: for instance an agreement with the distribution in which it commits to offering a given (minimum) quantity/volume of sustainable consumer goods within their product assortment.
- Agreements between the industry and consumer organizations: the objective is to achieve better protection for the consumer, in analogy with the collective labour agreements

Examples:

- Agreement between government and the distribution sector: in Flanders, the distribution sector has an agreement with the authority to make sustainable cleaning products visible on the shelves.
- Agreement between government and the industry: the Direct Mail Agreement in the UK commits the Direct Mail Association to cut down on waste by improving the targeting of direct mail campaigns and by publicising services such as the Mail Preference Service, which enables people to stop direct mail being sent to them.
- Agreements between central governments and subordinate governments or local authorities e.g. to fulfil preventions tasks. Sometimes connected with subsidies.
- Agreements between governments and notified bodies in the frame of extended producer responsibility schemes.
- Consumer agreements.

Instruments

A voluntary agreement can be incited by a legal obligation, e.g. a producer responsibility scheme, where the legal provision sets the targets and where the voluntary agreement details the way in which the targets will be reached.

Other voluntary agreements stand on its own as an independent regulatory instrument with a mere moral authority.

Policy cycle

Voluntary agreements regulate the quantity and the quality of the waste generated. They affect the pressure and the impact, thus P and I in the DPSIR model.

Point of impact in the life cycle of materials and products

Voluntary agreements can have impact on most life phases of a product, depending on the parties that are involved (industry, distribution, consumers).

Sources

- Flemish Waste Agency (2009) Analysis of innovative environmental policy instruments towards the realisation of environmentally responsible production and consumption, OVAM, Mechelen (Belgium), pp. 94 + attachments.

3.5.4 Lifecycle factsheets

3.5.4.1 Design

Description

Goal:

Reducing the environmental impact of products and services throughout their entire life cycle, including the reduction of the amount or changing the nature of raw material used.

Strategy:

Thinking process before the product is produced, a service is developed or the raw materials are used, but after the decision has been taken to generate a specific product or service. It results in an optimised design in view of its ecologic impact, namely *ecodesign*.

Remarks:

- The design phase includes more than the product oriented ecodesign, but it includes as well commercial strategy development, market positioning, etc.
- A pitfall can be that the design causes no waste at production / assembling site, but might cause a lot of waste elsewhere.
- Not merely prevention but the whole supply chain could be considered in the design phase. Waste prevention can lead to increased pollution, e.g. due to long travel distances of components.

Examples:

- Minimisation of raw material used:
  - Minimising material inputs – dematerialisation, product downsizing, minimising total material requirement of products/ecological rucksack
- Minimisation of waste during manufacturing
  - Redesign and production optimisation
  - Improving ecodesign through awareness raising on hidden costs and inefficient use of raw materials
  - Optimisation of packaging waste from components
- Distribution:
  - Minimising amount of packaging through optimisation of packaging design of the product
  - Designing packaging for re-use in multiple cycles and open or closed retour systems
- Use:
  - Improving product durability and wear-resistance
  - Designing to avoid waste during use stage, minimise needed consumables, minimise need for maintenance or repair
- End of life:
  - Design in accordance with the cradle-to-cradle philosophy
  - Minimising the amounts of hazardous substances, substitution of hazardous substances
  - Design for disassembly

- Design for recycling e.g. single materials
- Design for re-use

Instruments

Legal instruments

- Product standards, cfr. Energy Using Products Directive/Ecodesign Directive, Batteries Directive, WEEE Directive, ELV Directive, Packaging Directive, ROHS Directive, REACH, Product Warranty Directive, etc.
- Essential Requirements on packaging e.g. minimising the weight of the packaging to the minimum needed for safety, hygiene and consumer acceptance.
- Prevention targets, cfr. WFD, WEEE Directive, Batteries Directive, ELV Directive, etc.

Economic instruments

- Financial stimuli (positive and negative): e.g.
  - Raw material tax, cfr. *aggregates tax* in the UK
  - Tax on disposable products, cfr. *ecotax* in Belgium
  - Landfill and incineration tax, stimulating design for recycling
- Extended producer responsibility schemes leading to ecodesign
  - Sometimes initiated by a voluntary agreement, sometimes by a legal obligation

Communication and other instruments

- Awareness raising / education
- Eco-labels
- Voluntary agreements
- Green public procurement

Impact on other phases in the life cycle of materials and products

The prevention measures in the design phase of a product have impact on several phases in the life cycle of a product. They influence the need for raw materials and thus influence the amount of extraction and of extraction waste. Design usually is related to the production phase, where it leads to adapted production processes. However, aspects of packaging (in the distribution phase) or use (product durability, need for consumables or spare parts) are taken into consideration in the design phase. Finally, waste aspects (physical and chemical properties of the waste that will be generated in the post-consumer phase, e.g. through EPR) and properties in the end-of-waste phase can be taken into consideration. The design phase and eco-design are therefore to be considered as a horizontal strategy par excellence, overviewing the whole life cycle right from the beginning of it.

Sources

- M. Pullinger (2009) Reducing waste through promoting product ecodesign: a discussion paper, Scottish Government Social Research, Edinburgh, pp. 57

- M. Huber, R. Pamminger, W. Wimmer (2007) Ecodesign in a life cycle perspective. Waste prevention of products – a question of design and consumer patterns, Poster: 2nd Boku Waste Conference, Universität für Bodenkultur, Wien; 17.04.2007 - 19.04.2007; in: "*Waste matters. Integrating views*", Facultas.wuv, Wien (2007), ISBN: 978-3-7089-0060-5; S. 315 – 324

Frame 9 : Packaging and Packaging Waste Directive; Essential Requirements interfering in the decision process [50]

The Essential Requirements in the Packaging and Packaging Waste Directive are translated in CEN standards[51]. They state a.o.: *Packaging shall be so manufactured that the packaging volume and weight be limited to the minimum adequate amount to maintain the necessary level of safety, hygiene and acceptance for the packed product and for the consumer.*

The translation into CEN standards focus on the analysis in the decision taking process, and not on quantitative targets to be reached. Enforcement could focus on competent authorities participating in this thinking process at the level of individual decisions in companies on their packaging strategy for individual products. Companies could for example check beforehand and on their initiative with the authorities if their ideas are compliant with the Essential Requirements. Authorities can take their responsibility in supporting companies to catch the Essential Requirements in letter and spirit and to incorporate them in their due diligence. Especially the SME's could benefit from a cooperative approach.

[50] ARCADIS for DG ENV, A Survey on compliance with the Essential Requirements in the Member States (ENV.G.4/ETU/2008/0088r), Final report, 2009 - unpublished

[51] EUROPEAN STANDARD EN 13428, July 2004, ICS 13.030.99; 55.020 - Packaging - Requirements specific to manufacturing and composition - Prevention by source reduction

3.5.4.2 Extraction

Description

Goal:

Prevention of waste during the process of extraction in the mining industry and prevention of waste in the bio-based non extractive production (agriculture, fishery, forestry).

Strategy:

Eco-efficient extraction and resource production process using Best Available Techniques: avoiding extraction waste and reducing the environmental impact of this waste and promoting use of renewable resources.

Remarks:

- Resource efficiency is also obtained by re-using or recycling the primary waste of the extraction process. (≠ prevention)
- Resource efficiency is best served by replacing newly extracted raw materials by secondary raw materials from a recycling process (≠ prevention).
- Forestry, agriculture and other bio-based processes can lead, just as extraction processes for fossil fuels and metals to depletion of resources, land use, biodiversity and human rights if not sustainably managed (≠ waste or waste prevention issue)

Examples:

- Fisheries:
  - minimisation of by-catch and lost nets, by using better fishery techniques
  - recycling of fish residues or by-catch (≠ prevention)
- Agriculture:
  - Harvest remains reused or minimised
  - Hazardous content in manure (e.g. copper in pig manure) avoided
- Fossil resources:
  - technological solutions for minimisation of drilling waste volume
  - substitution of hazardous extraction substances
  - substitution of fossil fuel by wasteless[52] renewable alternatives (wind, water, sun).
  - use of solid materials and by products (usually considered waste) for e.g. roadbed material, asphalt or brick manufacture (≠ prevention)
  - recycling of drilling muds (≠ prevention)
- Metals:
  - technological solutions for minimisation of residues from the metallurgical process, from the abatement system or effluent treatment, etc. (cfr. BREF)
  - substitution of hazardous extraction substances
  - substitution of the use of metals, by other (primary or recycled) materials entailing less or no extraction waste
  - recycling of sludges etc. (≠ prevention)
- Construction minerals:

[52] Wind, water and sun as an energy source are wasteless in the production phase (with the exeption of limited maintenance), although waste is generated during the construction, maintenance or the decommissioning of the installations.

  - Substitution of primary raw materials (e.g. gravel) by secondary raw materials (e.g. broken C&D waste fulfilling environmental and technical conditions)
  - Use of solid materials and by products (usually considered waste) for e.g. soils, foundations, cores of dikes …
- Forestry: not relevant:
  - The impact of extraction in forestry, especially tropical forestry is less on waste, but more on biodiversity, (non) sustainable use of land, climate, etc.

Instruments

Legal instruments

- Technology standards (Best Available Techniques), cfr. IPPC Directive
- Product standards, cfr. ROHS Directive, Packaging Directive, etc.
- Prevention targets, foreseen in Waste framework Directive

Economic instruments

- Financial stimuli (positive and negative), such as a raw material tax (e.g. *aggregates tax* in the UK), landfill tax, etc.

Communication and other instruments

- Awareness raising and education
- Voluntary agreements

Impact on other phases in the life cycle of materials and products

The prevention measures in the extraction phase, especially the measures for qualitative prevention, have a direct impact on the exposure in all subsequent phases, especially the production phase and the consumption phase. They influence the hazard characteristics of the product and its waste.

Quantitative prevention measures in the extraction phase only affect the extraction waste and do not interfere with the further life cycle of the raw material in products and waste.

The extraction phase is largely influenced by the design phase and the decisions taken on ecodesign. They influence – in a market driven economy – the demand for specific raw materials and thus the quantity of extraction.

Sources

- Owens et al. (1993) Exploration and production (E&P) waste management guidelines Report No.2.58/196, E&P Forum, London, pp. 43.
- IPPC (2001) Reference Document on Best Available Techniques in the Non Ferrous Metals Industries, pp. 755.

3.5.4.3 Production

Description

Goal:

Prevention of waste during the production of the product.

Strategy:

Eco-efficient production processes using Best Available Techniques: avoiding production waste and reducing the environmental impact of this waste

Remarks:

- Resource efficiency is also obtained by recycling the primary waste of the production process. (≠ prevention)
- Resource efficiency is best served by replacing newly extracted raw materials by secondary raw materials from a recycling process (≠ prevention).
- Production can be designed environmental friendly and cause a minimum of waste due to socially irresponsible labour practices

Examples:

- Technological solutions to avoid spilling of raw material during production
- Technological solutions to minimise the generation of products that do not comply with the quality standards
- Good-house-keeping measures to avoid spilling of (raw) materials and consumables
- Buying raw material and consumables in bulk
- Substitution of hazardous substances
- Minimising product failure
- Etc.

Instruments

Legal instruments

- Technology standards (Best Available Techniques), cfr. IPPC Directive[53]
- Prevention targets, foreseen in Waste Framework Directive
- Obligatory environmental management systems, e.g. EMAS. EMAS call for defining measurable objectives in the continuous improvement of the environmental performance of the production site.

Economic instruments

- Financial stimuli (positive and negative), such as a raw material tax (e.g. *aggregates tax* in the UK), landfill tax, etc.
- Extended producer responsibility, making producers responsible for the packaging of the products they import for use in their production process.

[53] ETC/SCP thinks BAT is not specific enough on waste prevention for most sectors

Communication and other instruments

- Awareness raising / education
- Calculation and awareness raising on total cost of waste generation: costs associated with purchasing, transport and processing of material that will become waste.
- Voluntary agreements e.g. free environmental management systems like ISO14001

Technical instruments

- Ecodesign: design leading to resource efficient production
- Remanufacturing (≠ prevention)

Impact on other phases in the life cycle of materials and products

The prevention measures in the production phase, especially the measures for qualitative prevention, have a direct impact on the exposure in all subsequent phases, especially the consumption phase and the waste phase. They influence the hazard characteristics of the product and its waste.

The production phase is largely influenced by the design phase and the decisions taken on ecodesign. They influence – in a market driven economy – the demand for specific products thus the quantity of production and production waste

Sources

/

3.5.4.4 Distribution

Description

Goal:

Prevention of waste during the distribution of the product, namely waste prevention in the transport, storage and distribution sector.

Strategy:

Avoid damaging products during transport, good house keeping in order to avoid food waste (cfr. expiry date) and reduction of packaging. Packaging will be the main focus in this stage, as well as losses in storage, shipment, wholesale and retail.

Packaging is inseparably connected with the transition from producer to consumer, which takes place during the distribution phase. Although only secondary and tertiary packaging waste is generated during this phase, also the primary packaging that generated waste only in the consumer phase, is examined, as it too is essential for the above mentioned transition.

A more structural impact on distribution is generated by legal provisions on allowed or not allowed entry on the European market.

Examples:

- Ban or tax on single use bags
- Reusable pallets
- Reusable packaging
- Better storage and shipment conditions avoiding losses
- Better throughput from production to use avoiding too long storage and losses (especially for food products)
- Market ban on non RoHS compliant electrical and electronic equipment
- Market ban on non Essential Requirements compliant packaging
- Other market ban provisions…
- Choice editing and other distribution strategies

Instruments

Legal instruments

- Product standards (e.g. Essential Requirements of the Packaging Directive)
- Market bans, in different product oriented environmental legislation
- Prevention targets, foreseen in Waste framework Directive

Economic instruments

- Financial stimuli (positive and negative)
- Extended producer responsibility and take back obligations e.g. on packaging

Communication and other instruments

- Awareness raising / education
- Voluntary agreements

- Green marketing
- Choice editing and other distribution strategies as part of marketing

Technical instruments

- Ecodesign: design leading to minimised packaging for primary, secondary and tertiary packaging.

Impact on other phases in the life cycle of materials and products

The prevention measures in the distribution phase mainly have impact on the waste generated in the consumption phase, namely on a reduction of the amount of primary packaging waste.

The distribution phase is largely influenced by the design phase and the decisions taken on ecodesign. In accordance with the Essential Requirements on packaging in the design phase decisions have to be taken to minimise the weight and volume of the packaging necessary for safety, hygiene and consumer acceptance of the packaged product.

The distribution phase has to connect the production phase with the consumption phase, and therefore has to take care of a good and timely throughput of goods with as few losses as possible.

Sources

- Decision taking processes in the distribution sector, OVAM, 2007

Frame 10: Waste less distribution systems

Self dispensing is a waste-less or waste reduced distribution option[54]. Goods are taken to stores in bulk packaging and sold without primary consumer packaging. A dispenser is used for whatever packaging or container is provided for by the clients. Self dispensing systems are being developed in niche markets for specific dry products, such as rice or nuts. The system is extended in the US to dry goods, detergents…

The distribution sector is co-responsible on achieving the goals of the Essential Requirements for packaging and Packaging Waste. In Czech Republic and Portugal a legal provision is adopted for the distribution sector to provide along with products in single use packaging the same range of products in reusable packaging, if existing. When a distributor offers e.g. beverages in a single use packaging he is obliged to offer comparable products in the same range in a reusable packaging. In this way the consumer is give the freedom of choice between reusable and non reusable alternatives, and a market can be created or maintained for the reusable alternative, thus promoting quantitative prevention.

[54] ARCADIS for DG ENV, A Survey on compliance with the Essential Requirements in the Member States (ENV.G.4/ETU/2008/0088r), Final report, 2009 - unpublished

3.5.4.5 Use/consumption

Description

Goal:

Prevention of household waste and similar commercial waste/industrial waste[55] that is generated during the consumption or use of the product.

Strategy:

Influencing consumer behaviour towards more sustainable consumption patterns. Limiting the amount and avoiding hazardous characteristics and environmental impact of post-consumer waste.

Examples:

- Food waste prevention (planning meals, using leftovers)
- Smart shopping (no plastic bottles, no over-packed goods, buying bulk products, buying refillables, etc.
- No junk mail
- Buying services in stead of goods, e.g. buying experiences (concerts, theatre…) as gifts.
- Re-use (buy second-hand products, re-use bags, nappies, reusable packaging etc.)
- Making optimal use of a product, i.e. using it as long as possible, considering repair and/or upgrade if necessary

Instruments

Economic instruments

- Financial stimuli (positive or negative):
  - Taxes and levies, e.g. pay-as-you-throw, tax on disposable products
  - Promotional campaigns or discount coupons for sustainable or reusable products
  - Deposit refund schemes

Communication and other instruments

- Labelling
- Awareness raising / education
- Marketing, publicity, lead systems towards sustainable products outside and inside the store
- Voluntary agreements, e.g. agreements between government & distribution or collective consumer agreements
- Green public procurement

[55] Consumer/use waste is a basket concept. It comprises all waste that is not generated in a production or extraction context, and that is no secondary waste from waste treatment. It includes household waste as well as waste from non-production activities in industry or other organisations, but not waste from wastewater treatment or comparable. Consumption waste generates from the use of a product or an equipment that becomes waste, or from the consumables or spare parts connected to the use of a product or equipment.

Impact on other phases in the life cycle of materials and products

The prevention measures in the use/consumption phase are frequently closely connected to the measures in the distribution phase. These measures reflect on the transaction between distributor and consumer; the choice for specific products, waste-less shopping, guidance towards sustainable products etc. Also when prevention focuses on reuse through take-back-systems, the distribution phase is very important for the reverse logistics.

Prevention measures in the use phase are also connected to the end-of-waste phase when focussing on re-use, often after cleaning or refurbishment.

Sources

- Flemish Waste Agency (2009) Analysis of innovative environmental policy instruments towards the realisation of environmentally responsible production and consumption, OVAM, Mechelen (Belgium), pp. 94 + attachments.
- Defra (2009) WR1204 Household Waste Prevention Evidence Review: L2 m1 – Technical Report A report for Defra's Waste and Resources Evidence Programme, Brook Lyndhurst, London, pp. 121.

3.5.4.6 Waste

Description

Goal:

Reducing the environmental impact of products when they enter the waste phase. Mainly qualitative prevention on the properties of the waste, to allow for optimal treatment with minimal environmental impact.

Strategy:

Optimising the waste to allow a treatment method as high as possible on the waste treatment hierarchy; preparing for reuse, product and material recycling, energy recovery or safe disposal.

If one has to deal with the waste as it is created by those who discard it, any attempt to influence the waste content in this phase is to qualify as treatment and not as prevention.

Examples:

- Ecodesign focussing on the waste phase (although done in the design phase and implemented in the production phase)
  - Design in accordance with the cradle-to-cradle philosophy; 100% reusability, recyclability or biodegradability.
  - Reducing the amounts of hazardous substances, substitution of hazardous substances.
  - Design for disassembly.
  - Design for recycling e.g. single materials. (≠ prevention)
  - Design for re-use
  - Design for longevity.
- Adapted collection schemes for preparing for reuse
  - Source separated collection schemes of waste fit for preparation for reuse. (bring system or collection on demand)
  - Centralised sorting of reusable waste from other recyclable, recoverable or disposable waste.
  - Source separated collection or central sorting for recycling (≠ prevention)
- Quality guarantees for second hand goods, avoiding waste to be treated or shipped as a (low quality) non-waste.

Instruments

Legal instruments

- Prevention targets, cfr. WFD, WEEE Directive, Batteries Directive, ELV Directive, etc.
- Acceptance criteria for landfills and incinerators leading to qualitative prevention.
- Sorting obligations

Economic instruments

- Financial stimuli (positive and negative): e.g.
  - Tax on disposable products, cfr. ecotax in Belgium

- Landfill and incineration tax, stimulating design for recycling or reuse
- Extended producer responsibility schemes leading to leading to reverse logistics of reusable waste
  - Sometimes initiated by a voluntary agreement, sometimes by a legal obligation
  - E.g. WEEE

Communication and other instruments

- Awareness raising / education
- Voluntary agreements

Impact on other phases in the life cycle of materials and products

The waste phase is the phase usually taken into account when prevention activities are being made in all other stages of the material life cycle. The waste phase can follow each other stage of the material life cycle. A large proportion of waste is generated as extraction waste or mining waste, immediately following the extraction phase. The production phase is a source of pre-consumer or industrial waste. In most EU countries the quantity of industrial waste is eight to ten times the amount of household waste. In the distribution phase the major waste stream generated is packaging waste. The consumption phase leads to post consumer waste, and the waste phase itself leads to important fractions of secondary waste. The waste from the end-of-waste phase should be seen as the extraction, production… waste of a new cycle.

However, when “prevention” is considered in a broader scope than merely “waste prevention”, the link between the waste phase and the prevention measures in the other life cycle phases does not need to be this strong. Prevention can be set up to eliminate or reduce at source of materials, water and energy consumption, liquid, gaseous and heat emissions or hazardous or harmful substances.

Sources

- Irish EPA Waste Prevention Plan

3.5.4.7 End-of-waste

Description

Goal:

Reducing the environmental impact of products when they enter and end-of-waste phase as a secondary raw material, a recycled product, or a product made of recycled components or materials.

Strategy:

Taking care of the quality of the recycling processes and of the application of end-of-waste conditions to avoid that hazardous substances can enter the new product life cycle. Sometimes prevention in an end-of-life phase is comparable with prevention in an extraction phase, except for the extraction waste.

Examples:

- Minimisation of raw material used: reducing material inputs by using secondary raw materials
- Quality control on the recycling processes
  - In the end-of-waste phase it should be prevented that e.g. illegal flame-retardants enter new products made of recycled material from old plastic objects that contained these flame retardants.
- Set up of reuse shops, marketing of recycled materials

Instruments

Legal instruments

- Product standards on secondary raw materials, incl. REACH
- End-of-waste criteria to perform qualitative prevention and quality assurance
- Waste shipment Regulation 1013/2006/EC avoiding ecodumping of disputable 'second hand' goods or preventing low quality recycling.

Economic instruments

- Financial stimuli for the use of recycled materials

Communication and other instruments

- Eco-labels
- Quality labels
- Voluntary agreements
- Green public procurement

Impact on other phases in the life cycle of materials and products

The end-of-waste phase is the start of a new stage in the material life cycle. The end-of waste material enters a new production, distribution, use and finally new waste phase.

Sources

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Frame 11: Integrating risk analysis in the evaluation of transfrontier shipments of waste

Product standards - as imposed by RoHS, REACH or comparable instruments - have an impact on the composition of products in the use phase but also in the waste phase and the end-of-waste phase.

For example, according to RoHS newly produced electrical and electronic equipment may from 1 July 2006 onwards not contain more than a maximum concentration value of 0,1 % by weight in homogeneous materials for polybrominated biphenyls (PBB) and polybrominated diphenyl ethers (PBDE). These were formerly used as flame retardants in a.o. the plastic housing and printed circuit boards of electronic equipment or the plastic covering of cables.

Equipment older than 2006 still may contain higher levels of these brominated flame retardants. The plastics once entered in the waste phase are allowed to be recycled. The risk exists that in an end-of-waste phase through recycled material newly made components could contain more than allowed quantities of hazardous substances (e.g. the mentioned flame retardants) as a residual pollution, even it the mentioned flame retardants are not added on purpose. Newly generated products from recycled materials cannot enter the European market when they do not fulfil the product standards.

Problems could however rise when cables or other non hazardous wastes that contain components above the actual product standards are exported to non OECD-countries. According to the Regulation 1013/2006/EC on transfrontier waste shipment, non hazardous waste destined for recovery or recycling can be exported rather freely, if accompanied by a basic identification form. The Regulation does not succeed in preventing waste containing pollutants from being recycled. End-of-waste products generated and used outside EU could contain pollutants that are forbidden within the Union, pollutants originating from EU-waste.

A risk analysis on end-of-waste products could be integrated when allowing wastes to be shipped outside the EU for recycling.

3.6 Stakeholder consultation

3.6.1 Methodology

Based on the analysis above, a set of discussion topics on the key characteristics of waste prevention has been defined. This is presented to a set of stakeholders and priority witnesses. The discussion topics and the feedback retrieved by the stakeholders are included in Annex 1.

3.6.2 Stakeholders consulted

Following stakeholders have been consulted. Al addressed groups did react, mostly with detailed and high quality feedback.

CEPI	*Confederation of European Paper Industries regrouping the European pulp and paper industry and championing this industry's achievements and the benefits of its products.*
EEB	European Environmental Bureau, Europe's largest federation of environmental organisations
ETC/SCP	European Topic Centre for Sustainable Consumption and Production of the European Environmental Agency
EUROPEN	The European Organization for Packaging and the Environment, industry and trade organization open to any company with an economic interest in packaging and packaged products.
EUROSTAT	Statistical office of the European Union. Its task is to provide the European Union with statistics at European level that enable comparisons between countries and regions.
FEAD	European organisation representing EU's waste management industry. Its members are national associations of waste management and environmental services, whose members are private and/or public waste management companies, active in all forms of waste management, distributed questionnaire to members
FOE	Friends of the Earth is an international network of environmental organizations in 70 countries. It is structured as a confederation. did not respond but supports the feedback given by EEB
Municipal Waste Europe	Network of national public waste associations and similar.
OECD WGWPR	OECD working group on waste prevention and recycling

RReuse	Specialised European network of national and regional social economy federations and enterprises with activities in re-use and recycling.
Vereniging afvalbedrijven	Dutch federation defending at national (NL) and international level the interests of waste management companies. Member of FEAD

The feedback of the stakeholders is summarised in Annex 1 and is integrated in the analysis above.

3.7 Conclusions

Based on the analysis above, following key characteristics can be proposed on waste prevention:

a) The definition as included in the waste Framework Directive, art. 3.12, remains the most important touchstone for the description of waste prevention. Mainly because it exists and it is legally embedded.

> *Measures taken before a substance, material or product has become waste, that reduce:*
>
> *(a) the quantity of waste, including through the re-use of products or the extension of the life span of products;*
>
> *(b) the adverse impacts of the generated waste on the environment and human health; or*
>
> *(c) the content of harmful substances in materials and products*

b) The definition covers two aspects: prevention of waste generation, and prevention of harm through waste.

c) Both aspects, also described as quantitative and qualitative prevention are closely joined together and cannot be balanced. Both are needed.

d) Prevention is a horizontal action taking place in all steps of the material flow, over extraction, production, distribution, consumption, waste and end-of-waste phases.

e) Prevention also takes place before the material flow starts, in the design phase where decisions of a strategic or technical nature are taken.

f) Prevention can be realised using legal provisions, voluntary agreements, economic instruments and incentives, communication and suasion, leading to strategic decisions or technical measures.

g) Based on the DPSIR model, prevention is a policy response interacting with mainly driving forces and pressures, and in case of harm prevention also with state and impact.

h) The definition of prevention includes reuse, in its distinct appearances. The distinction between ‘reuse' and ‘preparing for reuse' is not of a technical nature, but merely of a juridical nature. If performed on waste it is preparing for reuse, if performed on a non-waste, it is reuse.

i) Reuse or use as second-hand (as well as the use of new low quality products) should be evaluated taking into consideration the expected remaining lifespan and the expected fate of the product when it enters the waste phase. Qualitative prevention can be the key to the solution on the issue of reuse in non-OECD countries with limited treatment capacities.

j) Prevention requires different decisions and different policy measures than recycling or recovery. Design for recycling does not equal design for longevity. It is important to clarify the distinction between the different steps of the waste treatment hierarchy.

k) "Prevention" in an environmental context could be a concept larger than "waste prevention", including the elimination or reduction at source of material and energy consumption, waste arising (solid, gaseous, heat and liquid) and harmful substances. The general concept of prevention, applied on material flows, could be used to clarify the concept of waste prevention.

l) In line with the statement above, the impact of life cycle thinking should be considered when priorising prevention and waste prevention policy measures. However, life cycle thinking and life cycle analysis may not be used to dilute waste prevention actions. LCA does not integrate prevention criteria and specific dimensions. LCA studies and prevention programs are complementary approaches. Waste prevention is not subordinated.

m) Where article 4.2 puts the waste treatment hierarchy in the perspective of life cycle thinking, this is hardly the case for waste prevention which remains on top of the hierarchy. Prevention on non hazardous waste remains useful even if the waste could theoretically be treated without environmental impact. Prevention of harm can be considered as an essential step for the subsequent steps in the hierarchy or in the preferred treatment method according to life cycle thinking.

4 Task 2: Material flows and their impacts in the economy

4.1 Situation: transition from waste management to sustainable materials management

4.1.1 Environmental impact of waste

Because of the enormous number of waste streams, it is not feasible to target them all. In addition, not all waste streams have an equal environmental impact. Therefore, policies should address the waste streams for which specific waste prevention measures could have the largest impact on the reduction of the over all environmental impact. Policy measures can be either focused on the reduction of the quantity of waste or on the reduction of the environmental impact of waste. The largest effect will be generated when policy measures are focused on waste streams with both a large total environmental impact (often synonym of large quantities) and a large relative environmental impact per kg.

The European Union's Fifth Environment Action Programme identified the following waste streams as “priority waste streams”, because of their growing environmental impact: packaging waste, end of life vehicles, batteries and accumulators, electric and electronic equipment and hazardous household waste. The definition of these priority waste streams led directly to several EC Directives, such as Directive 94/62/EC 2 on Packaging Waste and Directive 2000/53/EC on End of Life Vehicles.

However, the environmental impact of the former priority waste streams was limited to the environmental impact of their collection, sorting and treatment. In the light of the current framework of sustainable resource management, the environmental impact of the total life cycle of a waste product should be taken into account.

4.1.2 Environmental impact of products

The life cycle of a (waste) product is often long and complicated. It covers all the areas from the extraction of natural resources, their design, manufacture, assembly, marketing, distribution, sale and use, to the eventual disposal of them as waste.

In 2008, the Flemish Waste Agency carried out a study to assess the environmental impact of different waste streams over their entire life span. A multi criteria analysis was performed, taking into account several parameters, such as greenhouse gas emissions, ozone depletion, acidification, use or resources, etc. According to this study, the following waste streams showed the highest environmental impact:

- mixed waste
- construction and demolition waste
- residual household waste
- paper
- plastics
- packaging waste
- tar
- oil
- medical waste.

In 2006, a study carried out for the European Commission on the environmental impact of product showed that products from only three areas of consumption

- food and drink
- private transportation
- housing

They are responsible together for 70-80 percent of the environmental impacts of private consumption.

The selection of waste prevention strategies could focus on these products with the highest environmental impact. However, other criteria for prioritisation are possible, such as load of hazardous substances, importance in the public opinion or importance to the economy (~increase in import dependence and lack of security in supply of these strategic materials, e.g. steal alloys of Cr, Mo, Ti, V, Co, Ni, Nb and Ta).

The priority waste streams of the Austrian Waste Prevention and Recycling Strategy were selected within a participation project by expert judgement. The following waste streams were identified as priority waste streams (in bracket the selection criteria are shown):

- construction and demolition waste (high mass flow)
- residual waste including residuals from incinerating this waste (high mass flow and strong increase)
- packaging waste (high on the agenda of private persons)
- batteries (high content of harmful substances)
- innovative services (innovative approaches).

In the upcoming Update of the Waste Prevention and Recycling Strategy, the Umweltbundesamt will likely propose to also look at waste which contains “strategic” materials.

4.1.3 Sustainable materials management

In 2005, the OECD Working Group on Waste Prevention and Recycling (WGWPR) launched a new work area on Sustainable Materials Management, which was a new approach in waste management strategies. Compared to traditional waste management, sustainable materials management adds a sustainability perspective and a life cycle perspective. Managing the material chain as a whole is essential to find sustainable answers to the waste issue. Waste management focuses mainly on the end of life phase, the phase where material becomes waste. However, it makes much more sense to regard the material chain as a whole.

Life cycle thinking applied to materials is not new. Both from the perspective of products as materials many initiatives have been developed which add lifecycle elements to existing policy areas and other activities. Such initiatives have been known under different names, such as “sustainable production and consumption”, “ecodesign”, “integrated product policy”, “eco-efficiency” or “sustainable natural resource use”. Although these initiatives start from different perspectives, they boil down to similar approaches by taking the life cycle perspective on the transformation of materials into products and services and, finally, into waste.

They have been labelled differently in the literature, depending on the focus of the initiatives in the life cycle:

- Sustainable production and consumption is a term for initiatives that aim to integrate chain analysis in decisions relating to production and consumption.
- Integrated product policy seeks to minimise environmental degradation by looking at all phases of a product's life-cycle (and taking action where it is most effective).
- Sustainable natural resource use investigates minimizing environmental impacts from the use of natural resources throughout the lifecycle.
- Sustainable materials management aims to minimize environmental impacts from the use of materials throughout the lifecycle.
- Eco-efficiency, finally, is a catch-all term intended to minimize environmental impacts of economic activities throughout the lifecycle.

In addition there are initiatives like Corporate Social Responsibility, or Ecodesign that share many of the views of the initiatives mentioned above.

4.2 Scope and methodology

The scope of this chapter is to describe quantitatively the current EU situation and near future development regarding waste and material generation and prevention. This includes material flows connected to the extraction/use of resources, the production of goods, waste generation and treatment.

The quantitative description of the EU material flows reveals:

- how much material is generated, treated and disposed of;
- and to which extent the material flows can be prevented.

The description covers at least:

- main (waste) material streams including metals, paper, glass, plastics, bio-waste, minerals;
- main waste streams from generating sectors such as industrial, agricultural & forestry, construction & demolition, household & similar as well as secondary waste;
- waste displaying most hazardous characteristics.

Then the key environmental impacts of the material flows are mapped. Figure 1 shows the simplified scheme of a model which fulfils all these requirements.

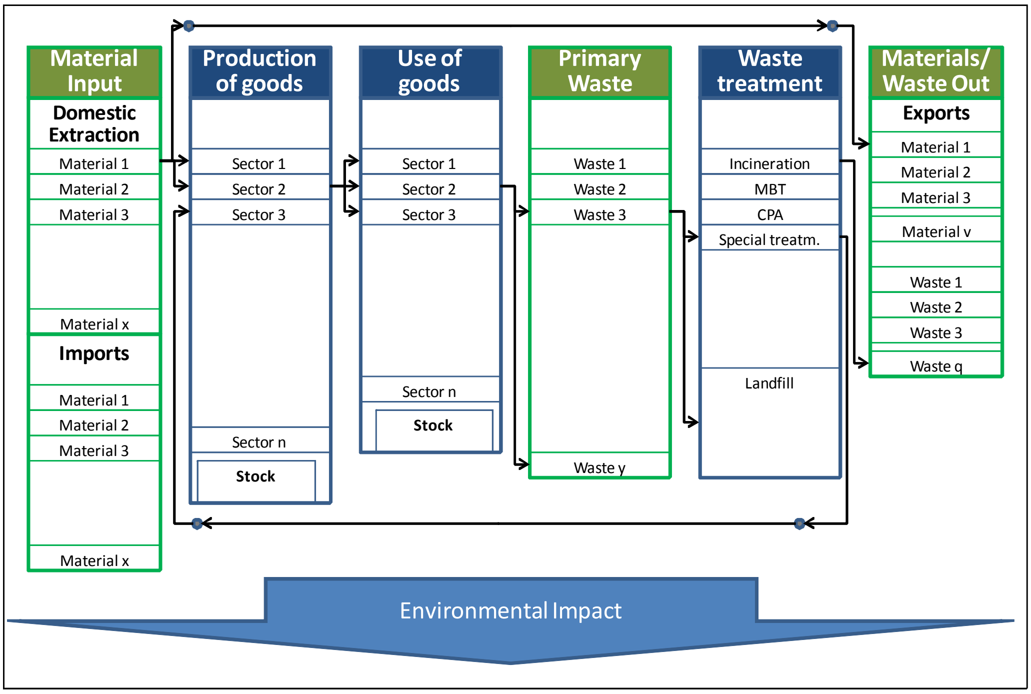

Figure 18: Simplified diagram of a material to waste model

However, there are many problems to be solved before such a model could provide realistic results:

- In reality material flows are quite complex. For example iron is used for the production of many different goods which are produced in many different sectors and used in virtually all sectors to be contained in hundreds of different waste types.
- The European Waste List categorises waste according to its sector of origin (e.g. mining waste), its material of origin (e.g. mineral oil waste) or its use (e.g. construction waste). This mix of criteria for categorizing waste, together with the complex path most materials follow through the economy, makes it difficult to determine the identity between material flows and the corresponding waste streams.
- Regularly measured are the Euros of input and output of the different sectors, the type of goods used in the sectors and the amount of waste generated by some sector aggregates, and the total amount of waste arising for some waste types. In addition specific studies on a less regular base measure/monitor the composition of certain goods and waste streams. This allows estimating the masses and, to a much lesser extend, the materials and waste streams as input and output of the sectors. It has to be accepted that the more complete and more detailed a model gets, the less measured and the more estimated values are involved.
- Not all material being put into the system comes out of the system in the same year. Some goods (such as batteries) stay within the system for a couple of years, electric equipment for a decade or two, construction material possibly for a century or two. Frequently the stocks which build up in the system are estimated from the difference between the input and the output. However, there not only the materials are piled up, but also the errors in the estimations of input and output flows.

In order to solve these problems, two approaches have been taken up to now:

- Approach 1 comprises material flow or substance flow analyses which try to simulate reality by a process oriented model, depicting the most important sectors, waste treatment processes and the material/waste flows connecting these sectors/processes in detail. This approach, however, needs to limit its scope, either to one substance (such as cadmium) or to few materials connected with few waste streams (such as minerals together with construction and demolition waste).
- Approach 2 comprises sector input/output models, which are based on national statistics estimating how many tons output from one sector are the input for the other sectors. The sector output can also comprise emissions and waste. To take into account waste data in the level of detail requested by the TOR, however, would require extremely extensive work.

The project scope does not allow building a new model in this level of detail. Relevant information and data which already exist have been collected and used to draw a quantitative description of the EUs' material and waste flows. The description comprises the EU as a whole. The advantage of only describing the EU level keeps the analyses more focused. The advantage of also describing the Member States would be that some differences between the Member States could be described.

As not only the current situation is mapped, but also the near future has been deducted from this current situation, it has been helpful to document the development, which has lead to the current situation. Therefore, wherever possible not only the most recent data but also the time-series have been taken into account.

4.3 Review of available data

4.3.1 Detailed approach

In this chapter a detailed estimate has been made of the amounts of data already available, in close consultation with EUROSTAT and the EEA. This subtask is performed in co-operation with the team of service request 5 "Preparatory Study for the review of the Thematic Strategy on the Prevention and Recycling of Waste" and is based on existing contacts with EUROSTAT, the European Environment Agency (EEA) and the European Topic Centre on Resource and Waste Management (ETC-RWM).

A first review of the data situation reveals the following picture:

- The main waste data source is EUROSTAT's data centre on waste (http://epp.EUROSTAT.ec.europa.eu/portal/page/portal/waste/introduction/). This is complemented by waste fact sheets collected and by studies on specific waste streams prepared by the EEA and the ETC-RWM. Consultation with different experts and a short internet research reveals additional available studies of interest. (for details see chapters 4.3.2. and 4.4)
- With respect to material inputs, EUROSTAT has collected a set of partly reported partly estimated data on the consumption of approximately 50 material types for the EU Member States in the period 2000 to 2005. This data set does not give the sector input, but the input for the country as whole. Upon official request, this data set has been made available to the present project by EUROSTAT (for details see chapter 4.6).

4.3.2 Results – availability of waste flow data

In European waste statistics a number of different waste categorization systems are applied:

- The European Waste List (EWL) according to Commission Decision (2000/532/EC)
- Waste streams defined by Regulation (EC) No 2150/2002 abbreviated EWC-Stat (e.g. EWC_101 "households and similar waste") as aggregates of the European Waste List for statistical purposes (see Table 9)
- Waste streams generated by economic branches as defined by NACE (e.g. HH "households") (see Table 9)
- Waste categories required by special purposes such as waste directives targeting specific groups of waste streams - these may or may not be derivable from EWL or EWC-Stat (see Table 9)
- Batteries (or more accurately "waste batteries")
- End-of-Life-Vehicles (ELV)
- Waste from electrical and electronic equipment (WEEE)
- Packaging waste
- Biodegradable waste (~ Biowaste)
- Construction and demolition waste (C&D)
- Municipal waste and Municipal solid waste (MSW)
- Secondary waste
- Material streams as defined by EUROSTAT questionnaires (see Table 40).

Table 9: Definitions of selected waste types

Waste type	Defined in EWL	Defined in EWC-Stat as	Defined elsewhere
Batteries (Waste batteries)	16 06 01* lead batteries 16 06 02* Ni-Cd batteries 16 06 03* mercury- containing batteries 16 06 04 alkaline batteries (except 16 06 03) 16 06 05 other batteries and accumulators 20 01 33* batteries and accumulators included in 16 06 01, 16 06 02 or 16 06 03 and unsorted batteries and accumulators containing these batteries 20 01 34 batteries and accumulators other than those mentioned in 20 01 33	08.41- Batteries and accumulators wastes	Directive 2006/66/EC: waste battery or accumulator' means any battery or accumulator which is waste
End-of-Life-Vehicles (ELV)	16 01 04* end-of-life vehicles 16 01 06 end-of-life vehicles, containing neither liquids nor other hazardous components	08.1 Discarded vehicles	Directive 2000/53/EC: 'vehicle' means any vehicle designated as category M1 or N1 defined in Annex IIA to Directive 70/156/EEC, and three wheel motor vehicles as defined in Directive 92/61/EEC, but excluding motor tricycles;

Waste type	Defined in EWL	Defined in EWC-Stat as	Defined elsewhere
			'end-of life vehicle' means a vehicle which is waste within the meaning of Article 1(a) of Directive 75/442/EEC;
Waste from electrical and electronic equipment (WEEE)	09 01 10 single-use cameras without batteries 09 01 11* single-use cameras containing batteries included in 16 06 01, 16 06 02 or 16 06 03 09 01 12 single-use cameras containing batteries other than those mentioned in 09 01 11 16 02 11* discarded equipment containing chlorofluorocarbons, HCFC, HFC 16 02 13* discarded equipment containing hazardous components other than those mentioned in 16 02 09 to 16 02 12 16 02 14 discarded equipment other than those mentioned in 16 02 09 to 16 02 13 20 01 23* discarded equipment containing chlorofluorocarbons 20 01 35* discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components 20 01 36 discarded electrical and electronic equipment other than those mentioned in 20 01 21, 20 01 23 and 20 01 35	08.2 Discarded electrical and electronic equipment	Directive 2002/96/EC: 'electrical and electronic equipment' or 'EEE' means equipment which is dependent on electric currents or electromagnetic fields in order to work properly and equipment for the generation, transfer and measurement of such currents and fields falling under the categories set out in Annex IA and designed for use with a voltage rating not exceeding 1 000 Volt for alternating current and 1 500 Volt for direct current; 'waste electrical and electronic equipment' or 'WEEE' means electrical or electronic equipment which is waste within the meaning of Article 1(a) of Directive 75/442/ EEC, including all components, subassemblies and consumables which are part of the product at the time of discarding;
Packaging waste	15 01 Packaging 15 01 01 paper and cardboard packaging 15 01 02 plastic packaging 15 01 03 wooden packaging 15 01 04 metallic packaging 15 01 05 composite packaging 15 01 06 mixed packaging 15 01 07 glass packaging 15 01 08* Packaging containing residues of or contaminated by dangerous substances 15 01 09 textile packaging 15 01 10* packaging containing residues of or contaminated by dangerous substances 15 01 11* metallic packaging containing a dangerous solid porous matrix (e.g. asbestos), including empty pressure containers	02.33 Packaging polluted by hazardous substances 06.31 Mixed metallic packaging 07.11 Glass packaging 07.21 Waste paper and cardboard packaging 07.41 Plastic packaging wastes 07.51 Wood packaging 10.21 Mixed packaging	Directive 94/62/EC: 'Packaging` consists only of: (a) sales packaging or primary packaging, i. e. packaging conceived so as to constitute a sales unit to the final user or consumer at the point of purchase; (b) grouped packaging or secondary packaging, i. e. packaging conceived so as to constitute at the point of purchase a grouping of a certain number of sales units whether the latter is sold as such to the final user or consumer or whether it serves only as a means to replenish the shelves at the point of sale; it can be removed from the product without affecting its characteristics; (c) transport packaging or tertiary packaging, i. e. packaging conceived so as to facilitate handling and transport of

Waste type	Defined in EWL	Defined in EWC-Stat as	Defined elsewhere
			a number of sales units or grouped packaging in order to prevent physical handling and transport damage. Transport packaging does not include road, rail, ship and air containers; 2. 'packaging waste` shall mean any packaging or packaging material covered by the definition of waste in Directive 75/442/EEC, excluding production residues;
Biodegradable waste (Biowaste)	Only partly defined: e.g. wood, paper... is not marked as biodegradable 12 01 19* readily biodegradable machining oil 13 01 12* readily biodegradable hydraulic oils 13 02 07* readily biodegradable engine, gear and lubricating oils 13 03 09* readily biodegradable insulating and heat transmission oils 20 01 08 biodegradable kitchen and canteen waste 20 02 01 biodegradable waste	Only partly defined: e.g. wood, paper... is not marked as biodegradable 05 Health care and biological wastes 11.12 Biodegradable sludges from treatment of other waste water	Council directive 1999/31/EC: 'biodegradable waste' means any waste that is capable of undergoing anaerobic or aerobic decomposition, such as food and garden waste, paper and paperboard Directive 2008/98/EC: „biodegradable waste" means any waste that is capable of undergoing anaerobic or aerobic decomposition, such as food and garden waste, paper and paperboard 'bio-waste' means biodegradable garden and park waste, food and kitchen waste from households, restaurants, caterers and retail premises and comparable waste from food processing plants;
Construction and demolition waste (C&D)	17 CONSTRUCTION AND DEMOLITION WASTES (INCLUDING ROAD CONSTRUCTION)	12.1 Construction and demolition wastes 07.73 Construction and demolition waste containing PCBs	
Municipal waste	20 MUNICIPAL WASTES AND SIMILAR COMMERCIAL, INDUSTRIAL AND INSTITUTIONAL WASTES INCLUDING SEPARATELY COLLECTED FRACTIONS	No definition	Council directive 1999/31/EC: 'municipal waste' means waste from households, as well as other waste, which, because of its nature or composition, is similar to waste from households:
Secondary waste	No definition	No definition	(EUROSTAT 2009a): Waste from Waste Management activities = Waste

Waste type	Defined in EWL	Defined in EWC-Stat as	Defined elsewhere
			from NACE Branches DN37 (Recycling) + G5157 (Wholesale of Waste and Scrap) + O90 (Sewage and refuse disposal, sanitation and similar activities)

EUROSTAT publishes at its web-page http://epp.eurostat.ec.europa.eu/ numbers on many European waste streams. Table 10 provides a summary of the most complete EUROSTAT data sets which are relevant to this study. Most of these data sets however show data gaps. In order to fill these gaps following assumptions were made:

- If there is a value for the preceding of subsequent time period (year), the gap is filled with this value.
- From those European Union Member States for which a complete data set is reported, the Member State which has the waste/capita ratio in the respective waste category most similar to the EU-27 average ratio is selected as reference country. The data gap is filled by dividing the value in the corresponding cell of the reference country by the reference countries population and multiplying the result with the population of the data-gap-country.

The EUROSTAT waste flow data are complemented by data of the European Environment Agency (EEA) on the generation of batteries waste and the generation and recycling of construction and demolition waste, end-of-life vehicles, municipal solid waste, packaging waste and waste from electric and electronic equipment (EEA 2009).

For data on the transboundary shipment of waste two European-Topic-Centre-reports (ETC-RWM 2008, ETC-SCP 2009) are used.

Table 10: Overview of waste data available with EUROSTAT

Waste Type	Activity/	EWCStat-Waste Types		Sectors/Branches		Countries	Years
Total Waste Hazardous waste Non-hazardous waste	Generation	Spent solvents	EWC_011	Agriculture, hunting and forestry	A	EU-27 + all EU Member States	2004 2006
		Acid, alkaline or saline wastes	EWC_012	Fishing	B		
		Used oils	EWC_013	Mining and quarrying	C		
		Spent chemical catalysts	EWC_014	Manufacture of food products; beverages and tobacco	DA		
		Chemical preparation wastes	EWC_02	Manufacture of textiles and textile products, leather and leather products	DB_DC		
		Chemical deposits and residues	EWC_031	Manufacture of wood and wood products	DD		
		Industrial effluent sludges	EWC_032	Manufacture of pulp, paper and paper products; publishing and printing	DE		
		Health care and biological wastes	EWC_05	Manufacture of coke, refined petroleum products and nuclear fuel	DF		
		Metallic wastes	EWC_06	Manufacture of chemicals, rubber and plastic products	DG_DH		
		Glass wastes	EWC_071	Manufacture of other non-metallic mineral products	DI		
		Paper and cardboard wastes	EWC_072	Manufacture of basic metals and fabricated metal products	DJ		
		Rubber wastes	EWC_073	Manufacture of machinery and equipment n.e.c., electrical and optical equipment, transport equipment	DK_TO_DM		
		Plastic wastes	EWC_074	Manufacture of furniture; manufacturing n.e.c.	DN36		
		Wood wastes	EWC_075	Recycling	DN37		
		Textile wastes	EWC_076	Waste management activities	DN37_G5157_O90		
		Waste containing PCB	EWC_077	Manufacturing excluding recycling	D_NOT_DN37		
		Discarded equipment (excluding discarded vehicles and batteries and accumulators waste)	EWC_080_NOT_081_0841	Electricity, gas and water supply	E		
		Discarded vehicles	EWC_081	Construction	F		
		Batteries and accumulators wastes	EWC_0841	Wholesale of waste and scrap	G5157		
		Animal waste of food preparation and products	EWC_0911	Other economic activities (services) excluding 51.57 and 90	G_TO_Q_NOT_G5157_O90		
		Animal faeces, urine and manure	EWC_093	Households	HH		
		Animal and vegetal wastes (excluding animal waste of food preparation and products; and animal faeces, urine and manure)	EWC_09_NOT_0911_093	Sewage and refuse disposal, sanitation and similar activities	O90		
		Household and similar wastes	EWC_101	All NACE branches plus households	TOT_NACE_HH		
		Mixed and undifferentiated materials	EWC_102				
		Sorting residues	EWC_103				
	Deposit onto or into land Disposal Incineration Land treatment	Dredging spoils	EWC_113				
		Common sludges (excluding dredging spoils)	EWC_11_NOT_113				
		Mineral wastes (excluding combustion wastes, contaminated soils and polluted dredging spoils)	EWC_121_TO_125_NOT_124				
		Combustion wastes	EWC_124				
		Contaminated soils and polluted dredging spoils	EWC_126				
		Solidified, stabilised or vitrified wastes	EWC_13				
		Total Waste					

	and release into water bodies Recovery Energy recovery Total treated				
Packaging waste	Generation Domestic Material Recycling Exports for Material Recycling Energy Recovery Incineration	Paper and board Plastic Wood Metals Aluminium Steel Glass Other Total Packaging Waste estimated		EU-27 + all EU Member States	2006, 2007
Municipal waste	Generation Landfilling Incineration Other Treatment	No	No	EU-27 + all EU Member States	1996 2001 2006

http://epp.eurostat.ec.europa.eu/statistics_explained/index.php?title=File:Municipal_waste.PNG&filetimestamp=20090430100031

http://epp.eurostat.ec.europa.eu/portal/page/portal/statistics/search_database

Accessed on 21-01-2010

4.4 Quantitative description of current status of waste flows

4.4.1 Detailed approach

In this chapter a quantitative description is made on the current EU situation regarding waste generation and prevention. At least for the youngest available year, a quantification of the amounts of waste generated, treated and disposed of has been made with respect to at least the following waste streams:

- Waste streams as defined by EWCStat (including metals, paper, glass, plastics, biodegradable waste (disaggregated into paper, wood and animal waste) minerals as well as household & similar waste)
- hazardous waste

The generation of following additional waste categories has been quantified:

- waste by NACE branch (including agricultural & forestry waste, different types of industrial (manufacturing) waste, waste from households, as well as waste from the waste management sector (mostly secondary waste))
- further special categories, such as construction & demolition waste, batteries, end-of-life vehicles, waste from electric and electronic equipment, municipal solid waste.

Based on the review of available data in chapter 4.3, the available data are collected and transferred into a common spread sheet. The different waste types are compared and described in overview graphics.

Data collection and analysis on waste flows and material flows are carried out at EU-27 level.

4.4.2 Results

The data collected are too voluminous to show all of them in this report. In Annex 2 the main data on waste generation and treatment flows, in Annex 3 the main data on the transboundary waste flows are reproduced. In the main text we show and discuss only the most important waste data.

4.4.2.1 Total Waste Generation by country, EWCStat-waste-type and NACE-branch

The generation of total waste in EU-27 for the years 2004 and 2006, disaggregated to non-hazardous waste and hazardous waste is shown in Figure 19.

The waste generation of EU-27 in 2006 by country is shown in Table 68 in Annex 2, the generation by waste category and by economic branch in Table 69 in Annex 2

The waste generation of EU-27 by economic sector for the years 2004 and 2006 is depicted in Figure 20.

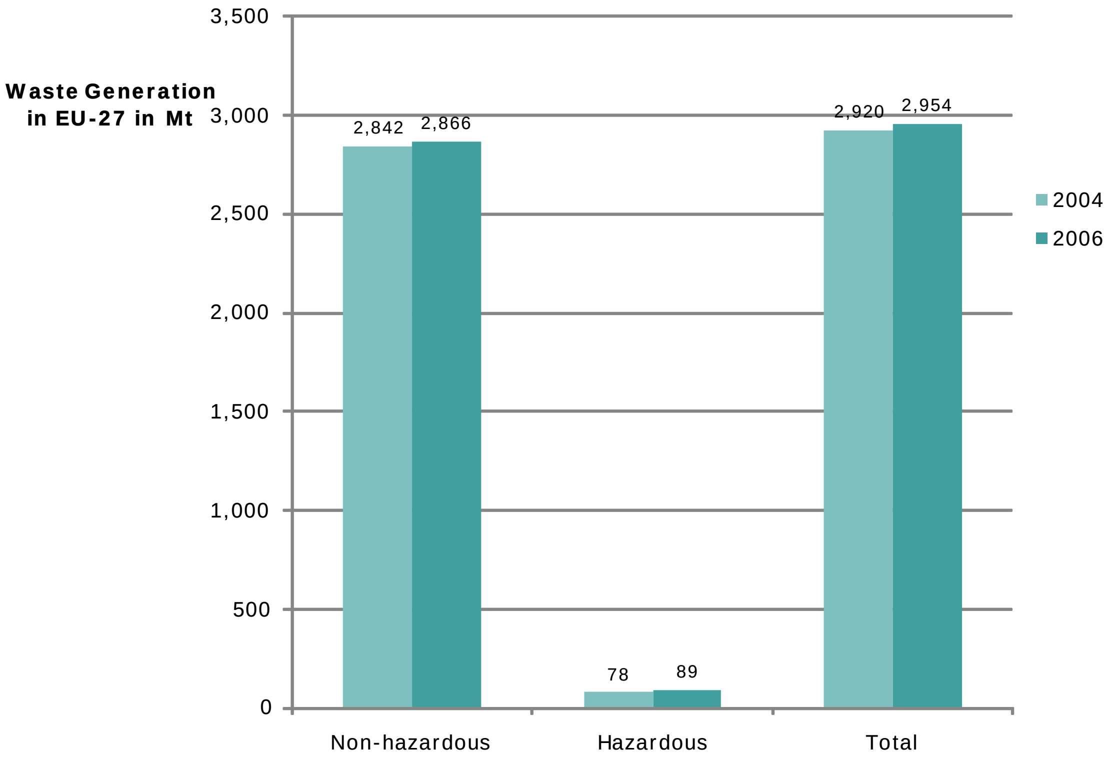

Figure 19: Generation of total waste in EU-27 (hazardous + non hazardous) (derived from EUROSTAT 2009a)

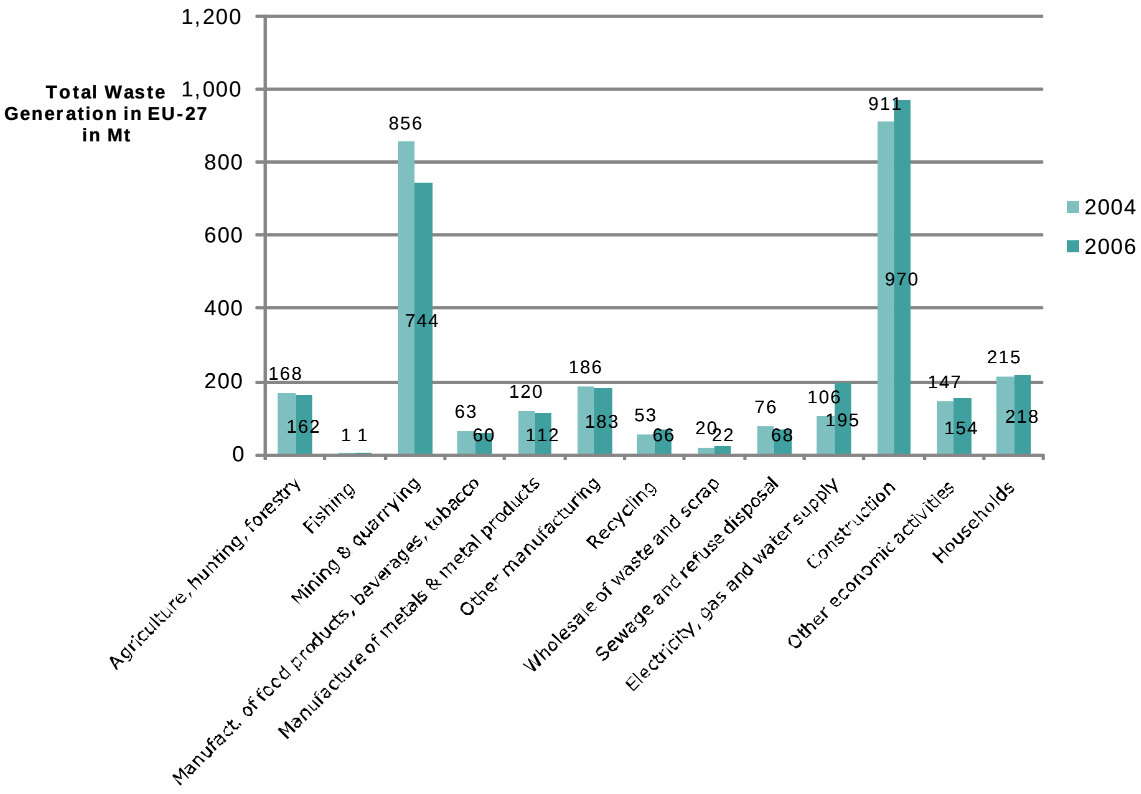

Figure 20: Total waste generation in EU-27 by sector/branch in 2004 and 2006 (derived from EUROSTAT 2009a)

The EU-27 waste generation of the year 2006 by waste type is shown in Figure 21 and Figure 22. The dominant role of mineral wastes can be seen from the latter.

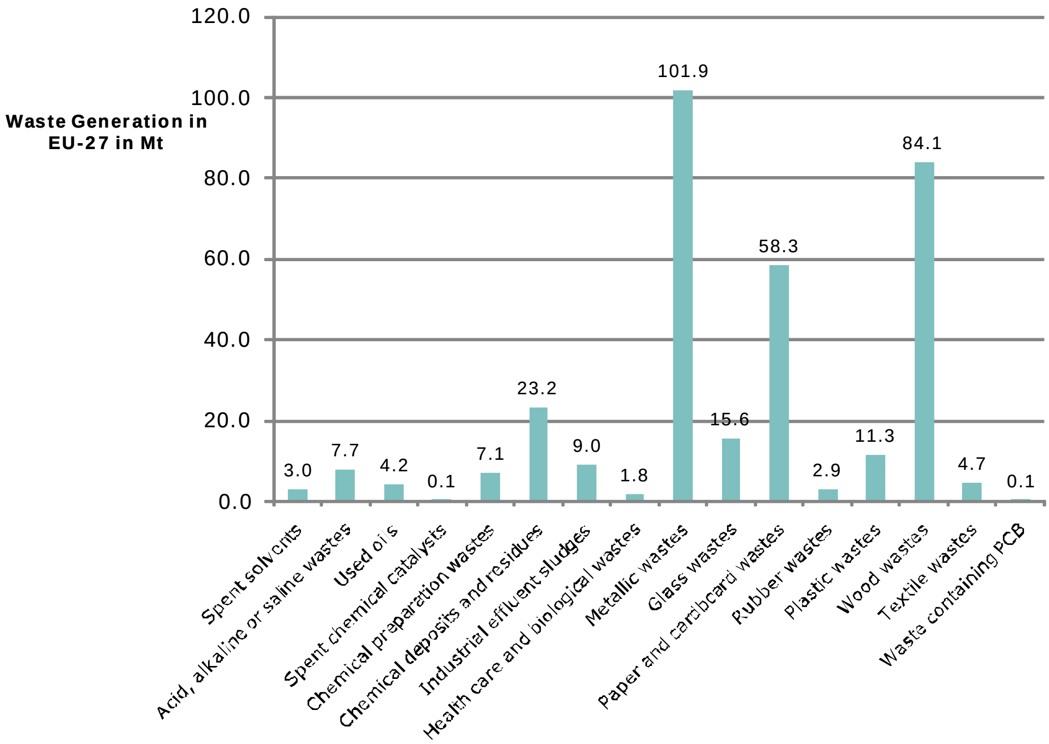

Figure 21: Total waste generation in EU-27 by EWCStat-Waste Category (part 1) in 2006 (derived from EUROSTAT 2009a)

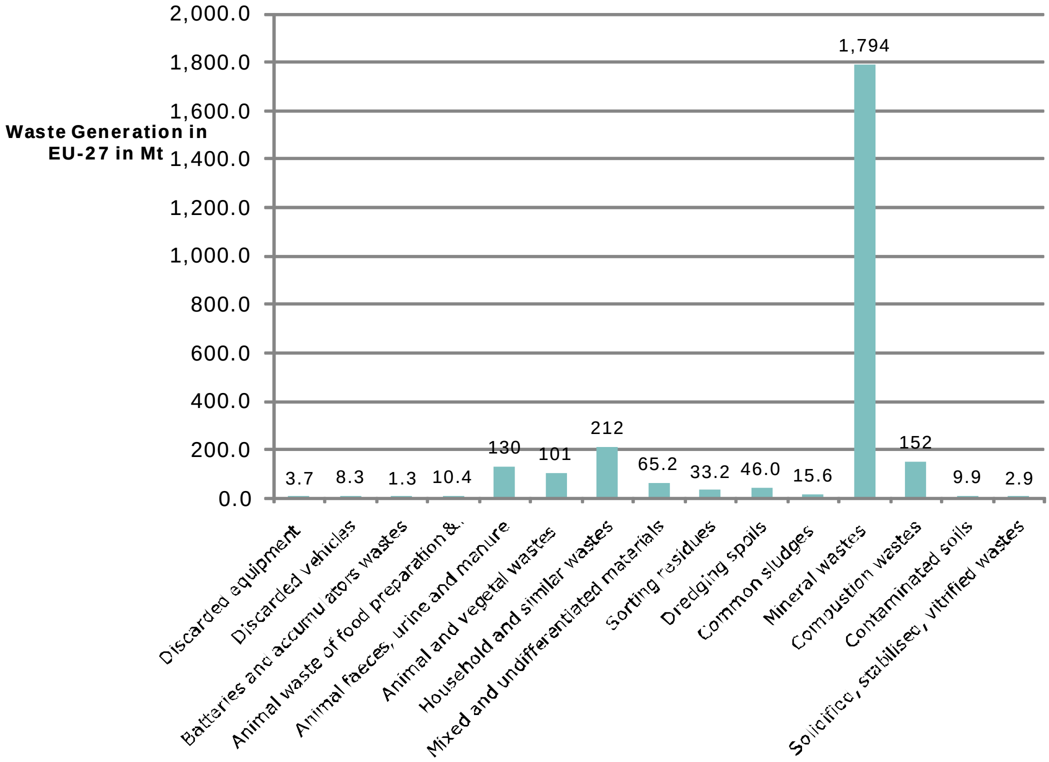

Figure 22: Total waste generation in EU-27 by EWCStat-Waste Category (part 2) in 2006 (derived from EUROSTAT 2009a)

4.4.2.2 Total Waste Treatment

The amount of waste treated by treatment category in EU-27 for the years 2004 and 2006 is shown in Figure 23. It shows the waste disposal is still the dominant form of waste treatment. Further detailed data are given in Table 70 in Annex 2.

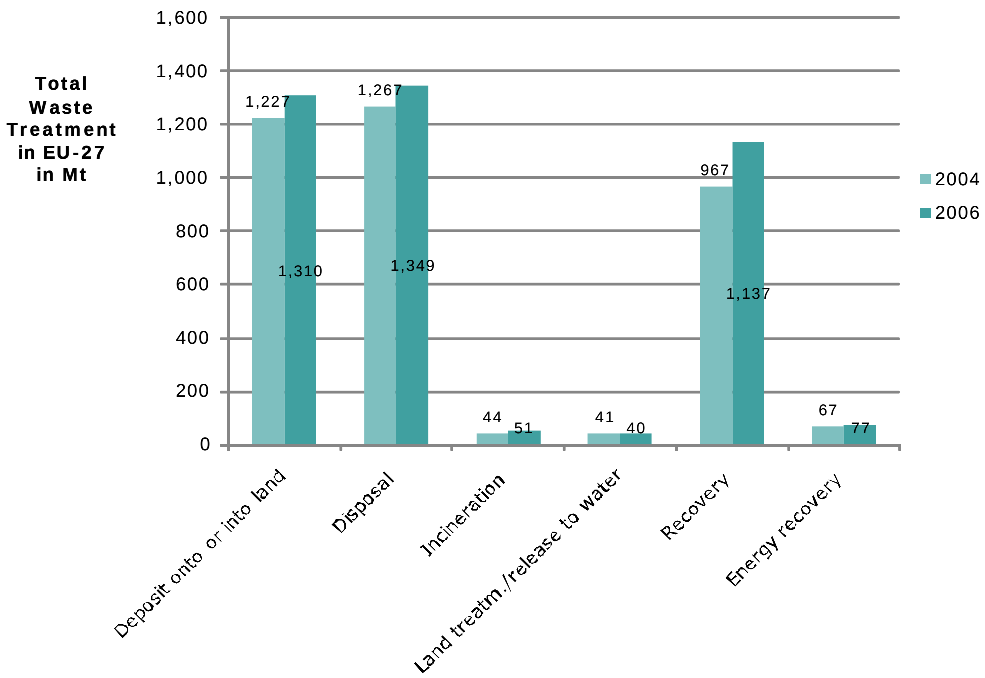

Figure 23: Total waste treatment in EU-27 in 2004 and 2006 (derived from Eurostat 2009a)

4.4.2.3 Hazardous Waste Generation

The generation of hazardous waste in EU-27 for the years 2004 and 2006 by economic branch is depicted in Figure 24, (showing, that the construction sector is responsible for the highest amount of hazardous waste generation); and by EWCStat-waste-type in Figure 25 and Figure 26, showing that mineral wastes, chemical deposits, combustion wastes and contaminated soils carry the biggest hazardous waste streams.

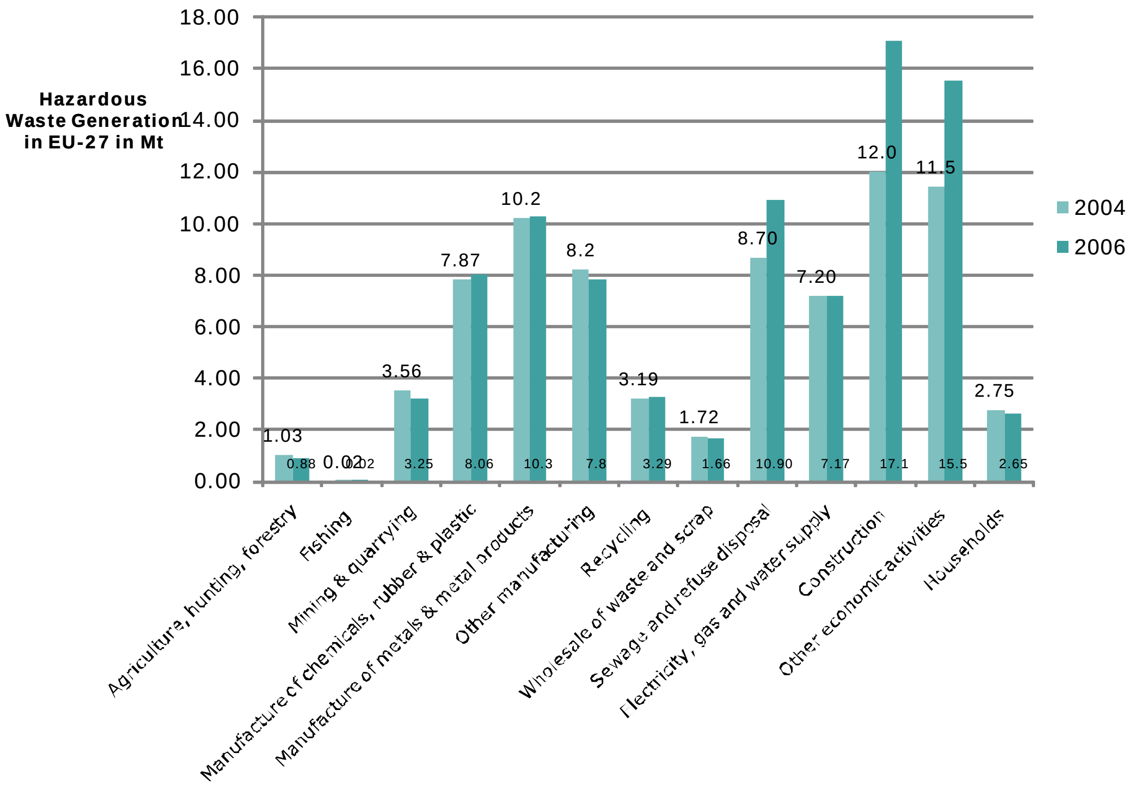

Figure 24: Hazardous waste generation in EU-27 by sector/branch in 2004 and 2006 (derived from EUROSTAT 2009a)

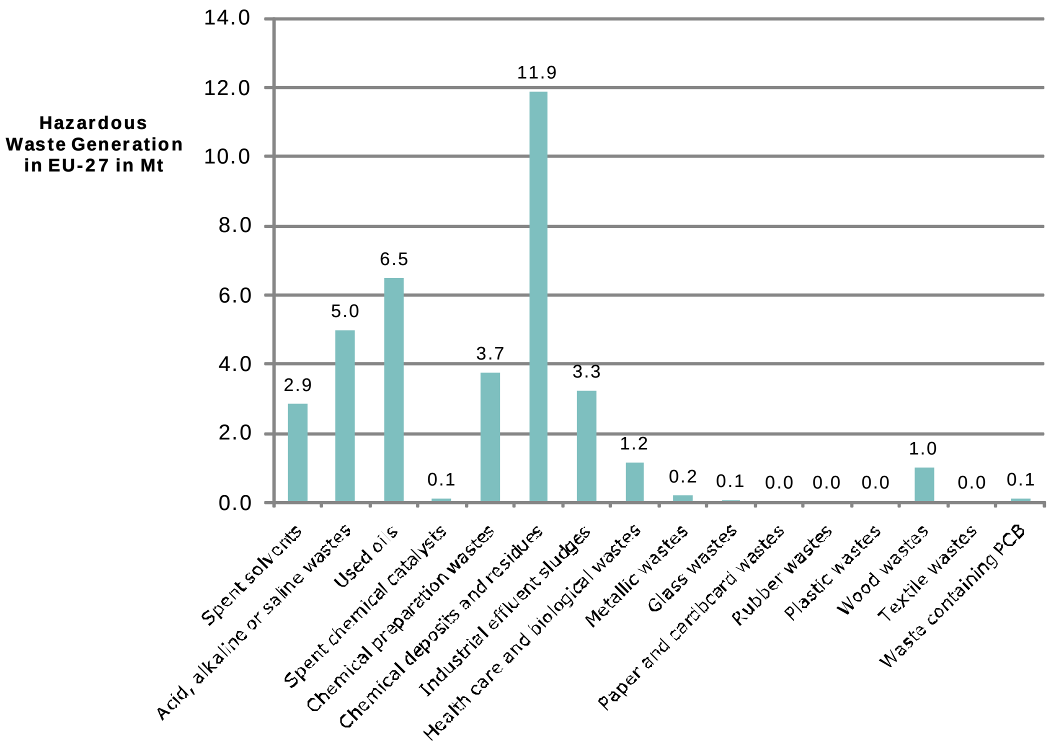

Figure 25: Hazardous waste generation in EU-27 by EWCStat-Waste Category (part 1) in 2006 (derived from EUROSTAT 2009a)

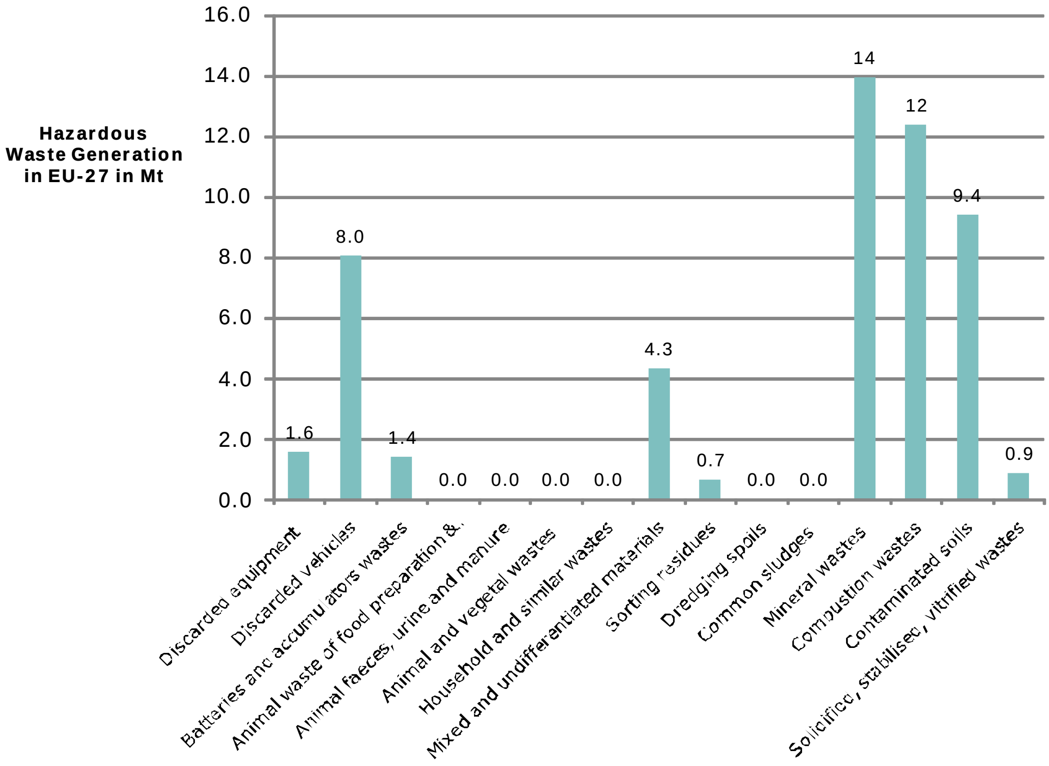

Figure 26: Hazardous waste generation in EU-27 by EWCStat-Waste Category (part 2) in 2006 (derived from EUROSTAT 2009a)

4.4.2.4 Hazardous Waste Treatment

The disaggregation of hazardous waste treatment by treatment category is shown in Figure 27 for the years 2004 and 2006. Also for hazardous waste the share of disposal is still surprisingly high. Recovery, however, in 2006 became the prevailing treatment option.

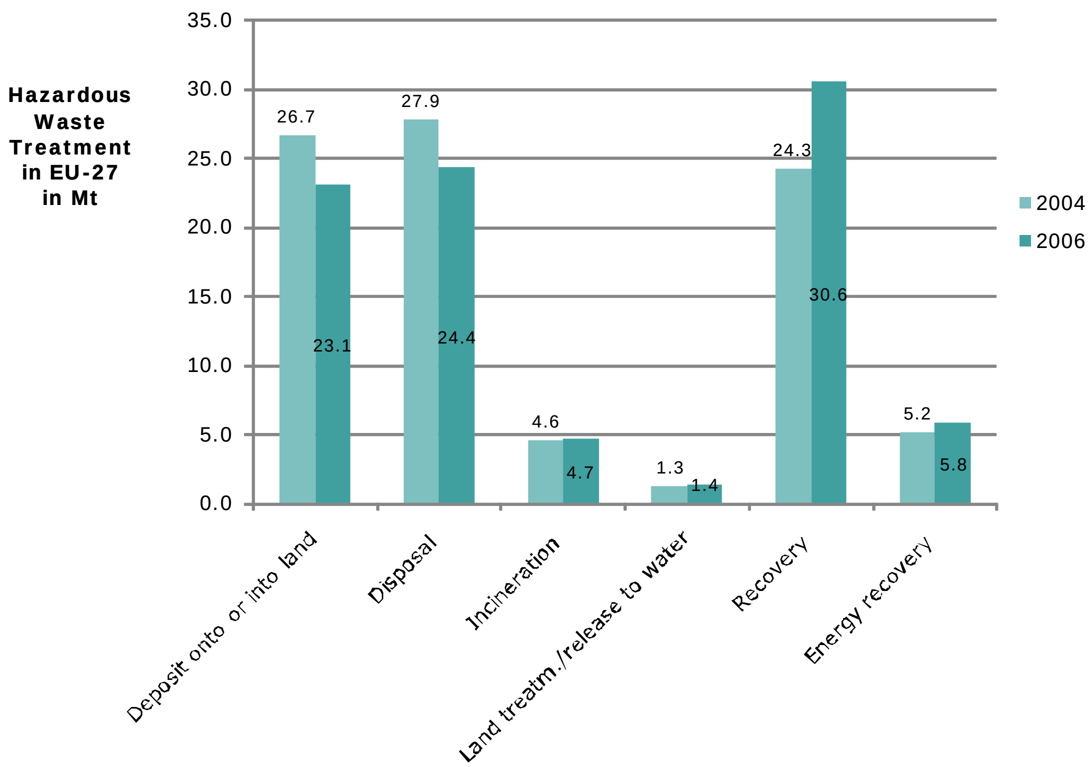

Figure 27: Hazardous waste treatment in EU-27 in 2004 and 2006 (derived from EUROSTAT 2009a)

4.4.2.5 Battery Waste

Table 11 shows the generation of waste from lead acid batteries in EU-27 and its countries fort he years 2004 and 2006; Table 12 the sales of portable consumer batteries as well as the mass of separately collected and recycled spent portable consumer batteries in selected countries.

Table 11: Generation of lead acid waste batteries (EEA 2009)

Year	2004	2006	2004	2006
Country Code	tonnes	tonnes	kg/capita	kg/capita
AT	20,453	19,318	2.51	2.34
BE	41,597	62,396	4.00	5.94
BG	2,398	1,091	0.31	0.14
CY	1,172	1,808	1.60	2.36
CZ	12,810	12,232	1.25	1.19
DE	273,603	301,705	3.32	3.66
DK	209	2,812	0.04	0.52
EE	4,615	3,532	3.42	2.63
ES	135,954	126,979	3.21	2.90
FI	18,464	45,339	3.54	8.63
FR	265,490	256,610	4.26	4.07
GR	78,953	43,060	7.15	3.87
HU	40,294	22,255	3.98	2.21
IE	6,151	1,449	1.53	0.34
IT	159,875	196,307	2.76	3.34
LT	3,354	3,637	0.97	1.07

LU	1,274	1,589	2.80	3.39
LV	357	4,288	0.15	1.87
MT	0	846	0.00	2.09
NL	36,387	49,523	2.24	3.03
PL	16,968	9,946	0.44	0.26
PT	10,656	197,698	1.02	18.70
RO	4,776	5,136	0.22	0.24
SE	46,287	44,862	5.16	4.96
SI	2,163	2,130	1.08	1.06
SK	5,630	3,703	1.05	0.69
UK	90,215	169,773	1.51	2.81
EU-27	**1,280,105**	**1,590,024**	**2.62**	**3.22**

Table 12: Sales, collection and recycling of portable consumer batteries (EEA 2009)

Country code	Year	Total sales/onto market, tonnes	Collection tonnes	Collection rate %	Recycling tonnes	Recycling % of collected
AT	2001	3,263	1,436	44	632	44
BE	2001	3,934	2,361	60	1,416	60
FR	2001	26,291	4,207	16	673	16
DE	2001	33,115	12,915	39	2,196	17
NL	2001	5,795	1,855	32	593	32
SE	2001	3,117	1,714	55	0	
EU15 + Switzerland + Norway	2002	161,572	27,467	17	4,120	15

4.4.2.6 Waste from End-of-Life-Vehicles (ELV)

Table 13 shows the end-of-life vehicles collected, reused, recycled and recovered, respectively in 24 EU Member States in the year 2006.

Table 13: Generation of waste from end-of-life vehicles, reuse, recycling and recovery in the year 2006 (EEA 2009)

Country code	Number of collected vehicles	Waste generation	Reuse	Recycling	Recovery
		in tonnes	in tonnes	in tonnes	in tonnes
AT	87,277	69,329	2,722	52,628	56,750
BE	131,043	131,030	24,359	89,953	92,941
BG	45,127	45,127	1,743	35,422	37,625
CY	1,032	918	54	730	741
CZ	56,582	48,094	1,250	36,744	39,678
DE	499,756	449,280	28,220	361,576	396,593
DK	102,202	99,354	11,044	68,182	68,503
EE	11,035	10,637	0	8,779	8,779
ES	954,715	885,689	79,712	595,807	663,870
FI	14,945	14,183	1,287	10,411	10,444
FR	930,000	837,000	117,177	549,166	560,793
GR	29,689	23,952	623	19,091	19,091
HU	20,976	16,380	1,206	12,089	12,143
IT	1,379,000	1,310,050	127,735	793,669	825,050
LT	13,877	14,057	5,976	6,392	7,022
LU	4,864	4,557	0	3,879	3,909
LV	6,288	5,659	669	4,198	4,198

NL	192,224	179,883	39,626	108,773	113,558
PL	150,987	124,173	14,002	91,223	92,536
PT	25,641	22,333	124	18,114	18,978
RO	21,234	17,624	235	13,357	13,912
SE	283,450	335,605	0	0	0
SK	15,069	11,907	465	9,392	9,499
UK	995,569	970,582	12,944	773,122	785,738
Total of 24 EU countries	**5,972,582**	**5,627,403**	**471,173**	**3,662,697**	**3,842,351**
Rate in %			**8.4**	**65.1**	**68.3**

4.4.2.7 Waste from Electric and Electronic Equipment (WEEE)

(EEA 2009) provides data on the sales electric and electronic equipment and on the collection amounts of its waste for 18 EU Member States representing 62 % of EU's population. From these data the sales electric and electronic equipment and on the collection amounts of its waste are extrapolated as shown in Table 14.

Table 14: Estimated amount of electric and electronic equipment sold and waste from electric and electronic equipment in EU-27 in the year 2006 (based on EEA 2009 data)

	Put on market	**Total collected**	**Collection rate**
Type of equipment	**Tonnes**	**Tonnes**	**%**
Automatic dispensers	59,790	15,904	26.6
Consumer equipment	1,406,555	364,822	25.9
Electrical & electronic tools	531,620	31,940	6.0
Gas discharge lamps	114,026	30,376	26.6
IT & Telecommunication	1,574,568	336,142	21.3
Large household appliances	4,464,003	1,175,943	26.3
Lighting equipment	493,344	20,463	4.1
Medical devices	84,475	8,664	10.3
Monitor & control instruments	74,781	2,968	4.0
Small household appliances	799,888	137,120	17.1
Toys, leisure & sports equipment	151,501	10,547	7.0
Total	**9,754,552**	**2,134,889**	**21.9**

4.4.2.8 Construction and demolition (C&D) waste

According to Table 15 some 970 million tons of waste were produced in the construction sector of EU-27 in the year 2006. From these 871 million tonnes is mineral waste.

Table 15: Estimated Generation of Waste in the Construction Sector in the year 2006 in EU 27 in million tonnes (Mt) (derived from EUROSTAT 2009a)

Waste category		**NACE - Branch**
		F
EWCStat-Name	EWCStat-#	**Construction**
Spent solvents	EWC_011	0.02
Acid, alkaline or saline wastes	EWC_012	0.02
Used oils	EWC_013	0.53
Spent chemical catalysts	EWC_014	0.00
Chemical preparation wastes	EWC_02	0.08
Chemical deposits and residues	EWC_031	0.54
Industrial effluent sludges	EWC_032	0.11
Health care and biological wastes	EWC_05	0.01

Metallic wastes	EWC_06	11.64
Glass wastes	EWC_071	0.54
Paper and cardboard wastes	EWC_072	1.58
Rubber wastes	EWC_073	0.05
Plastic wastes	EWC_074	2.79
Wood wastes	EWC_075	14.08
Textile wastes	EWC_076	0.01
Waste containing PCB	EWC_077	0.01
Discarded equipment (excluding vehicles & batteries)	EWC_080_ NOT_081_0841	0.07
Discarded vehicles	EWC_081	0.04
Batteries and accumulators wastes	EWC_0841	0.02
Animal waste of food preparation and products	EWC_0911	0.00
Animal faeces, urine and manure	EWC_093	0.00
Other animal and vegetal wastes	EWC_09_ NOT_0911_093	0.60
Household and similar wastes	EWC_101	1.13
Mixed and undifferentiated materials	EWC_102	13.91
Sorting residues	EWC_103	0.82
Dredging spoils	EWC_113	43.00
Common sludges (excluding dredging spoils)	EWC_11_NOT_113	0.14
Mineral wastes (excluding combustion wastes, contaminated soils and polluted dredging spoils)	EWC_121_TO_125 NOT_124	871.02
Combustion wastes	EWC_124	0.30
Contaminated soils and polluted dredging spoils	EWC_126	7.23
Solidified, stabilised or vitrified wastes	EWC_13	0.02
Total Waste		**970.3**

Figure 28 shows a time series of construction and demolition waste generation in EU-27 derived from data reported by (EEA 2009) by filling data gaps of some Member State reports by the respective preceding year's value. The achieved values are similar to the Eurostat value for mineral waste from the construction sector. According to the values shown in Figure 28 the growth rate of C&D waste generation lies with an average of 2.1%/a.

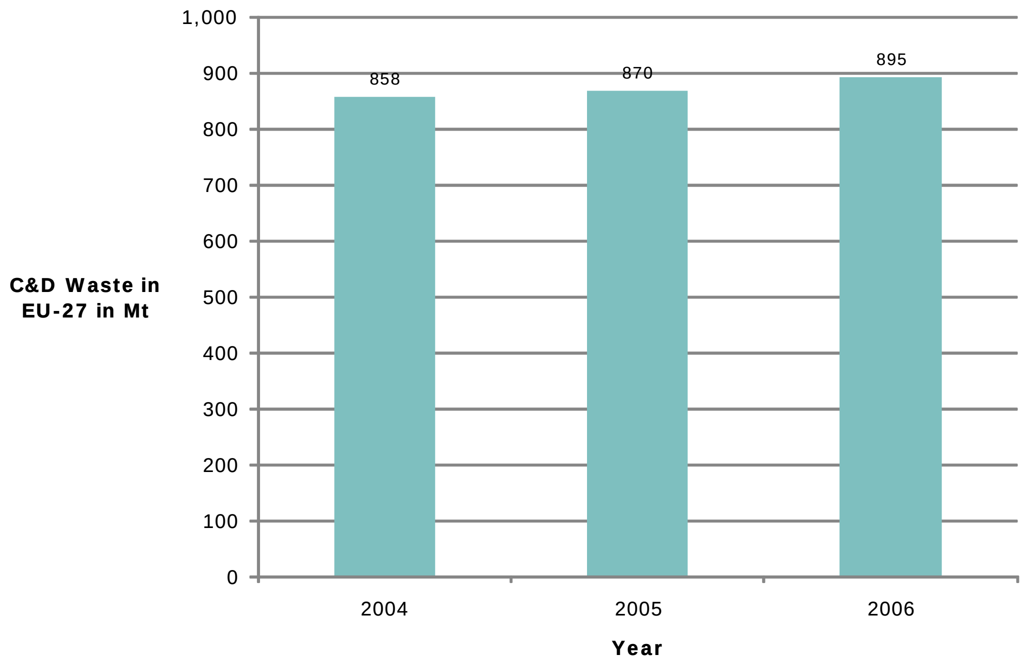

Figure 28: Generation of construction and demolition (C&D) waste in EU-27 in million tonnes (Mt) (based on EEA 2009 data)

4.4.2.9 Packaging Waste Generation

The generation of packaging waste in EU-27 for the years 2006 and 2007 are shown in Figure 29 and Table 16. The latter shows also the growth rate from 2006 to 2007.

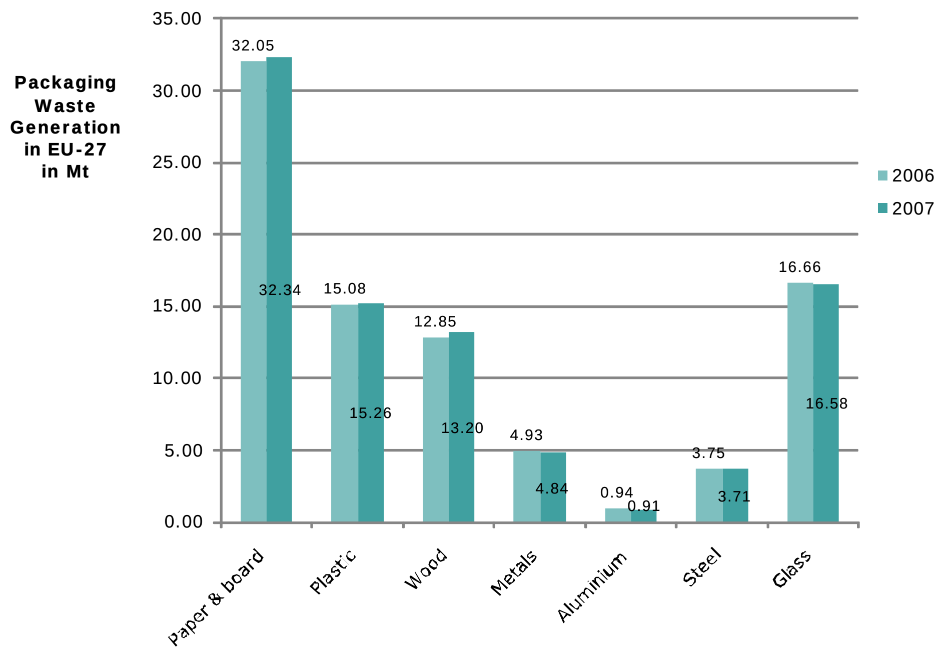

Figure 29: Packaging waste generation in EU-27 in 2006 and 2007 (derived from EUROSTAT 2009a)

Table 16: Packaging waste generation in EU-27 in million tonnes (Mt) (derived from EUROSTAT 2009a)

	Year		change in %
	2006	**2007**	
Paper & board	32.05	32.34	0.9
Plastic	15.08	15.26	1.2
Wood	12.85	13.20	2.7
Metals	4.93	4.84	-1.9
Aluminium	0.94	0.91	-3.6
Steel	3.75	3.71	-1.0
Glass	16.66	16.58	-0.4
Other	0.24	0.28	17.3
Total	**86.51**	**87.12**	**0.7**

4.4.2.10 Packaging Waste Treatment

The amount of packaging waste treated by material type and treatment mode is shown in Figure 30 and Table 17. The latter shows also that more packaging paper is treated (including export for treatment) than generated. This may be an indication that paper is also imported for treatment.

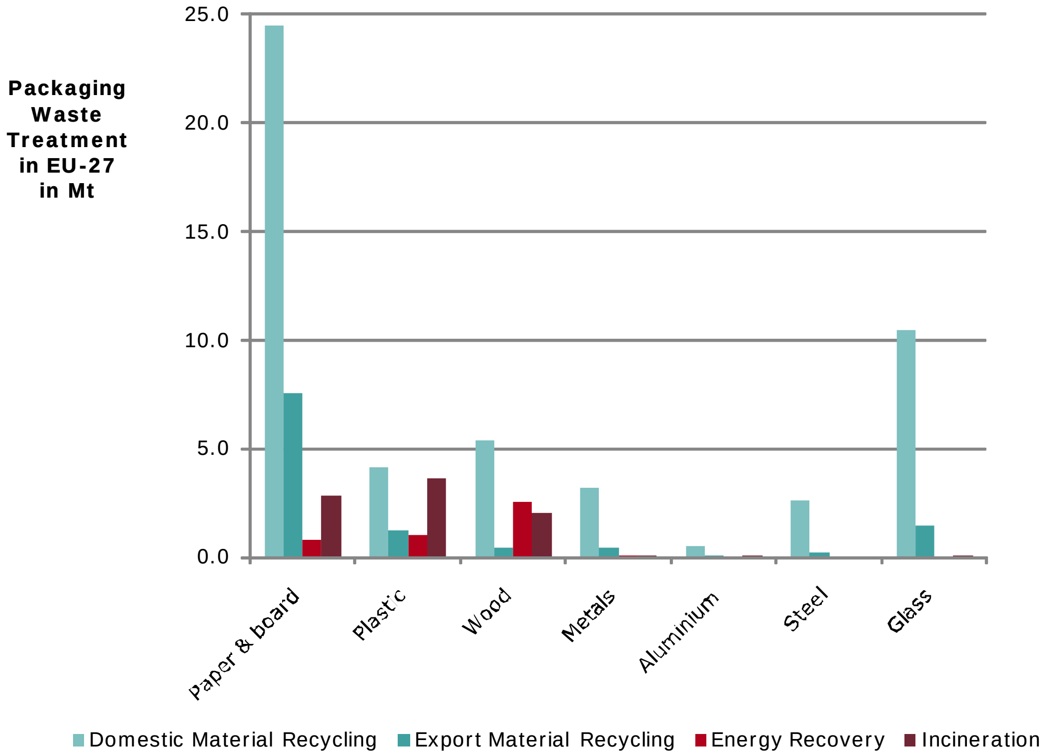

Figure 30: Packaging waste treatment in EU-27 in 2007 (derived from EUROSTAT 2009a)

Table 17: Packaging waste treatment in EU-27 in 2007 by treatment option in million tonnes (Mt) and share of treatment as compared to generation (derived from EUROSTAT 2009a)

	Domestic Material Recycling		Export Material Recycling		Energy Recovery		Incineration		Total treated	Total generated
	Mt	share in %	Mt	share in %	Mt	share in %	Mt	share in %	Mt	Mt
Paper & board	24.5	69	7.6	21	0.8	2	2.8	8	35.67	32.34
Plastic	4.1	41	1.2	12	1.1	10	3.7	36	10.08	15.26
Wood	5.4	52	0.4	4	2.6	25	2.0	19	10.42	13.20
Metals	3.2	87	0.4	12	0	0	0.04	1	3.68	4.84
Aluminium	0.5	81	0.05	7	0	0	0.08	12	0.66	0.91
Steel	2.6	92	0.2	8	0	0	0	0	2.81	3.71
Glass	10.4	88	1.4	12	0	0	0	0	11.89	16.58
Other	0.01	13	0	1	0.02	17	0.07	69	0.11	0.28
Total	**50.8**	**67**	**11.4**	**15**	**4.4**	**6**	**8.7**	**12**	**75.3**	**87.1**

4.4.2.11 Waste from Households and similar waste

Table 18 shows the amount of waste generated in the NACE-Branch “Households” for the years 2004 and 2006 in EU-27 by waste type. In contrast to this, Table 19 shows the generation of the waste type *“Household and Similar Waste”* in EU-27 by branch.

Table 18: Estimated Generation of Waste in the Household Sector in the years 2004 and 2006 in EU 27 in million tonnes (Mt) (derived from EUROSTAT 2009a)

Waste category		**NACE - Branch HH - Households**	
EWCStat-Name	**EWCStat-#**	**2004**	2006
Spent solvents	EWC_011	0.02	0.03
Acid, alkaline or saline wastes	EWC_012	0.00	0.01
Used oils	EWC_013	0.06	0.05
Spent chemical catalysts	EWC_014	0.00	0.00
Chemical preparation wastes	EWC_02	0.15	0.11
Chemical deposits and residues	EWC_031	0.00	0.01
Industrial effluent sludges	EWC_032	0.00	0.00
Health care and biological wastes	EWC_05	0.00	0.00
Metallic wastes	EWC_06	2.77	3.37
Glass wastes	EWC_071	7.84	7.23
Paper and cardboard wastes	EWC_072	16.35	16.68
Rubber wastes	EWC_073	0.19	0.16
Plastic wastes	EWC_074	1.67	2.17
Wood wastes	EWC_075	3.12	3.34
Textile wastes	EWC_076	0.75	0.79
Waste containing PCB	EWC_077	0.00	0.00
Discarded equipment (excluding vehicles & batteries)	EWC_080_NOT_081_0841	1.86	0.94
Discarded vehicles	EWC_081	1.89	1.89
Batteries and accumulators wastes	EWC_0841	0.10	0.11
Animal waste of food preparation and products	EWC_0911	0.05	0.09
Animal faeces, urine and manure	EWC_093	0.01	0.00
Other animal and vegetal wastes	EWC_09_NOT_0911_093	17.67	23.26
Household and similar wastes	EWC_101	149.91	146.12
Mixed and undifferentiated materials	EWC_102	5.85	6.24
Sorting residues	EWC_103	0.02	0.04

Dredging spoils	EWC_113	0.01	0.02
Common sludges (excluding dredging spoils)	EWC_11_NOT_113	0.17	0.17
Mineral wastes (excluding combustion wastes, contaminated soils and polluted dredging spoils)	EWC_121_TO_125_NOT_124	4.56	4.89
Combustion wastes	EWC_124	0.01	0.28
Contaminated soils and polluted dredging spoils	EWC_126	0.00	0.00
Solidified, stabilised or vitrified wastes	EWC_13	0.00	0.00
Total Waste		**215.04**	**218.0**

Table 19: Estimated Generation of *"Household and Similar Waste"* in the years 2004 and 2006 in EU 27 in million tonnes (Mt) (derived from EUROSTAT 2009a)

		Waste category	
	EWCStat-Name	**Household and similar wastes**	
	EWCStat-#	**EWC_101**	
NACE-Branch	**NACE Code**	**2004**	**2006**
Agriculture, hunting and forestry	A	0.35	0.40
Fishing	B	0.03	0.04
Mining and quarrying	C	0.05	0.06
Manufacture of food products; beverages and tobacco	DA	2.52	1.66
Manufacture of textiles and textile products, leather and leather products	DB_DC	0.59	0.46
Manufacture of wood and wood products	DD	0.60	0.43
Manufacture of pulp, paper and paper products; publishing and printing	DE	1.24	1.02
Manufacture of coke, refined petroleum products and nuclear fuel	DF	0.10	0.05
Manufacture of chemicals, rubber and plastic products	DG_DH	1.74	1.32
Manufacture of other non-metallic mineral products	DI	0.54	0.44
Manufacture of basic metals and fabricated metal products	DJ	0.83	0.97
Manufacture of machinery and equipment n.e.c., electrical and optical equipment, transport equipment	DK_TO_DM	2.64	1.96
Manufacture of furniture; manufacturing n.e.c.	DN36	0.85	0.64
Waste management activities	DN37_G5157_O90	6.19	6.55
Electricity, gas and water supply	E	0.76	0.39
Construction	F	1.33	1.13
Other economic activities (services) excluding 51.57 and 90	G_TO_Q_NOT_G5157_O90	41.75	40.89
Households	HH	149.9	146.1
All NACE branches plus households	**TOT_NACE_HH**	**212.0**	**204.5**

4.4.2.12 Municipal Solid Waste Generation and Treatment

(EEA 2009) provides data which allows estimating an annual time series of municipal solid waste generation in EU-27 for the period 1996 to 2006 by filling some data gaps. The result as show in Figure 31 is very similar to data reported by (EUROSTAT 2009b) for the years 1996, 2001 and 2006.

The (EUROSTAT 2009b) data also show the amount of municipal solid waste landfilled, incinerated and treated otherwise, respectively, as can be seen in Figure 32.

Table 20 furthermore shows the amount of municipal waste recycled in EU-27 with the respective recycling rates.

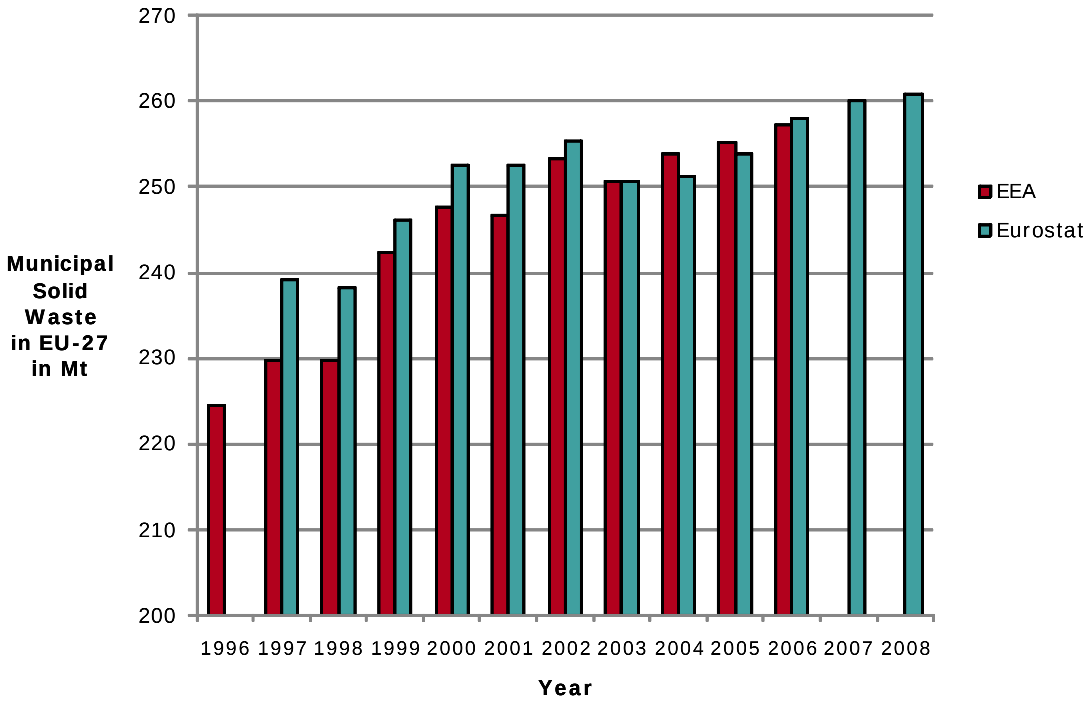

Figure 31: Generation of municipal solid waste in EU-27 derived from (EEA 2009) data and as reported by (EUROSTAT 2009b), respectively

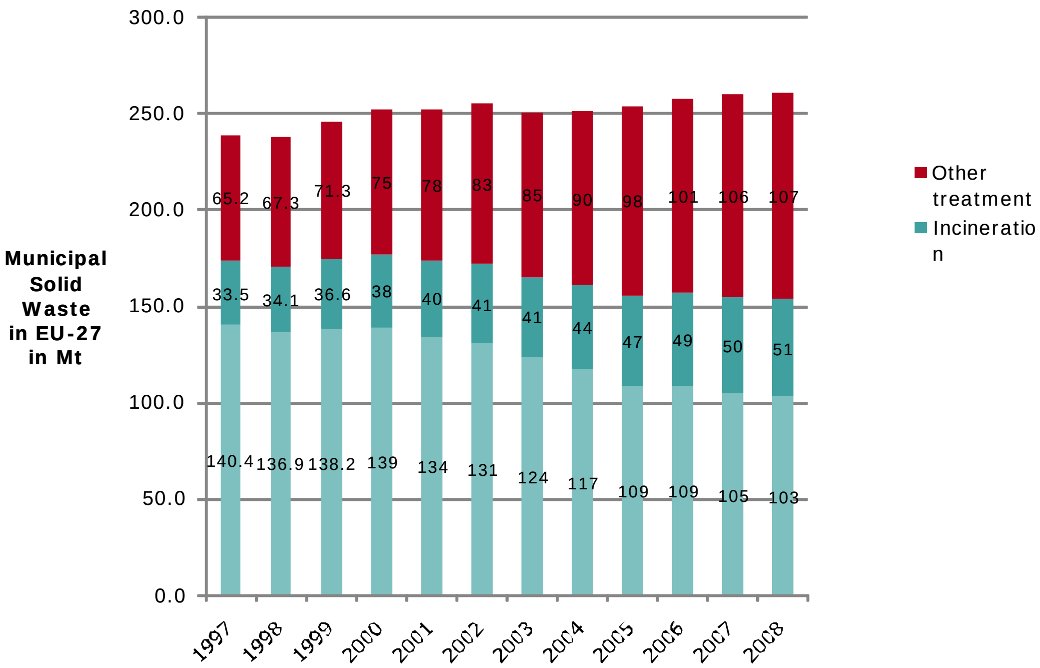

Figure 32: Treatment of municipal solid waste in EU-27 for the years 1997 to 2008 (EUROSTAT 2009d)

Table 20: Recycling of Municipal Solid Waste in EU-27 in million tonnes (Mt) (derived from EEA 2009)

	Year	2001	2002	2003	2004	2005
Total Recycling	in Mt	67.7	72.2	77.1	79.4	83.3
Recycling Rate	%	27.5	28.5	30.7	31.3	32.6

4.4.2.13 Waste Generation by the Waste Management Sector – Secondary Waste

The waste generation by waste category for the waste management sector of the year 2006 is given in Table 21. The majority of this can be considered as secondary waste.

Table 21: Estimated Waste Generation in the year 2006 in EU 27 in million tonnes (Mt) for the waste management, the construction and the household sectors by EWC-Stat Category (derived from EUROSTAT 2009a)

		Waste management activities (~secondary waste)			
Waste category	NACE - Branch	DN37	G5157	O90	DN37 + G5157 + O90
EWCStat-Name	EWCStat-#	Recycling	Wholesale of waste and scrap	Sewage and refuse disposal, sanitation and similar activities	Total Waste management activities
Spent solvents	EWC_011	0.02	0.04	0.23	0.29
Acid, alkaline or saline wastes	EWC_012	0.09	0.02	0.29	0.40
Used oils	EWC_013	0.12	0.09	0.49	0.70
Spent chemical catalysts	EWC_014	0.00	0.01	0.00	0.01
Chemical preparation wastes	EWC_02	0.20	0.07	0.93	1.20
Chemical deposits and residues	EWC_031	0.17	0.13	1.11	1.41
Industrial effluent sludges	EWC_032	0.17	0.05	1.98	2.20
Health care and biological wastes	EWC_05	0.00	0.00	0.02	0.02
Metallic wastes	EWC_06	24.74	14.22	2.62	41.58
Glass wastes	EWC_071	0.61	0.04	0.61	1.27
Paper and cardboard wastes	EWC_072	0.82	1.00	2.02	3.84
Rubber wastes	EWC_073	0.51	0.03	0.14	0.68
Plastic wastes	EWC_074	0.93	0.07	0.34	1.35
Wood wastes	EWC_075	3.10	0.11	1.60	4.81
Textile wastes	EWC_076	0.10	0.02	0.04	0.16
Waste containing PCB	EWC_077	0.01	0.00	0.01	0.02
Discarded equipment (excluding vehicles & batteries)	EWC_080_ NOT_081_0841	0.41	0.28	0.27	0.96
Discarded vehicles	EWC_081	4.77	0.36	0.09	5.22
Batteries and accumulators wastes	EWC_0841	0.13	0.16	0.11	0.41
Animal waste of food preparation and products	EWC_0911	0.33	0.01	0.08	0.41
Animal faeces, urine and manure	EWC_093	0.00	0.00	0.09	0.09
Other animal and vegetal wastes	EWC_09_ NOT_0911_093	0.10	0.02	2.68	2.80
Household and similar wastes	EWC_101	0.55	0.55	5.44	6.55
Mixed and undifferentiated materials	EWC_102	1.87	0.20	1.85	3.92
Sorting residues	EWC_103	15.13	1.61	14.61	31.35
Dredging spoils	EWC_113	0.07	0.03	0.20	0.30

Common sludges (excluding dredging spoils)	EWC_11_ NOT_113	0.03	0.02	9.06	9.11
Mineral wastes (excluding combustion wastes, contaminated soils and polluted dredging spoils)	EWC_121_TO_125 NOT_124	10.29	1.70	10.59	22.58
Combustion wastes	EWC_124	0.80	0.85	8.93	10.59
Contaminated soils and polluted dredging spoils	EWC_126	0.04	0.61	0.36	1.01
Solidified, stabilised or vitrified wastes	EWC_13	0.36	0.03	1.04	1.43
Total Waste		**66.5**	**22.3**	**67.8**	**156.7**

4.4.2.14 Transboundary Waste Movement

It has to be noted that the following tables make no differentiation between exports to other EU countries and exports to outside the EU.

The amount of hazardous waste exported by each of the 27 EU Member States is shown in Table 22. In total some 4.5 million tons were exported by these countries. Remarkable are the high per-capita hazardous waste exports of Malta and Luxembourg.

Table 22: Exported Hazardous Waste in 2007 in thousand tonnes (kt) and in kg/capita (ETC-SCP 2009)

	Export in kt	**Export in kg/capita**
AT	271.6	32.8
BE	641.5	60.6
BG	0.3	0.0
CY	0.3	0.4
CZ	5.5	0.5
DE	259.7	3.2
DK	142.6	26.2
EE	0.3	0.2
ES	17.6	0.4
FI	14.5	2.7
FR	357.1	5.6
GR	5.1	0.5
HU	38.2	3.8
IE	197.4	45.8
IT	988	16.7
LT	1.2	0.4
LU	188.3	395.4
LV	7.2	3.2
MT	678	1662.5
NL	60.3	3.7
PL	14.8	0.4
PT	171.8	16.2
RO	0.6	0.0
SE	209.8	23.0
SI	42.3	21.0
SK	4.2	0.8
GB	134.1	2.2
Total	**4,453**	**9.0**

The 20 largest hazardous waste streams (defined by the waste groups of the European waste list) exported from the 27 EU Member States are shown in Table 23. The largest exported hazardous waste streams are contaminated soils and residues from waste treatment.

Table 23: Export of the 20 largest hazardous waste types from 27 EU-Member States in 2007 (ETC-SCP 2009)

Waste group according to European Waste List (EWL)	EWL 4 digit number	Export in thousand tonnes (kt)
Soil (from contaminated sites)	1705	698.8
Wastes from physico/chemical treatment	1902	375.5
Wastes from incineration/pyrolysis of waste	1901	356.5
Wastes from iron&steel industry	1002	313.5
Batteries & accumulators	1606	259.2
Stabilised/solidified waste	1903	250
Wastes from the mechanical treatment of waste	1912	217.9
Wastes from production/use of basic organic chemicals	701	216.7
Wastes from aluminum thermal metallurgy	1003	172.3
Waste engine, gear and lubricating oil	1302	169.5
Wood, glass and plastics	1702	152.1
Insulation material and asbestos containing construction material	1706	148
Wastes from chemical surface trearment and coating of metals / other materials	1101	143.1
Wastes from the production/use of pharmaceuticals	705	86.5
Wastes from lead thermal metallurgy	1004	81.1
Oil/water separator content	1305	76.9
Wastes from electrical & electronic equipment	1602	76.6
Separately collected fractions	2001	76.3
Waste organic solventa, refrigerants, foam/aerosol propellants	1406	57.4
Bilge oils	1304	51.3
Total		**3,979**

The amount of the 20 largest notified non-hazardous waste streams exported from the 27 EU Member States in the year 2007 is given in Table 24. These waste streams comprise some 5 million tonnes. Several of the larger non-hazardous waste exports contain wood. It should be taken into consideration that notified non-hazardous waste streams are only a fraction of non hazardous waste streams exported for recovery or recycling for which no notification is requested under application of Regulation 1013/2006/EC.

Table 24: Export of the 20 largest notified non-hazardous waste types in 2007 from 27 EU Member States in thousand tonnes (kt) (ETC-SCP 2009)

Waste type according European Waste List (EWL)	EWL 6 digit number	Amount of waste exported in kt
wood (from mechanical treatment)	191207	986.7
combustible waste (from mechanical treatment)	191210	584.2
other wastes from mechanical treatment	191212	454.1
mixed municipal waste	200301	341.3
wood (C&D waste)	170201	308.9
sludges from treatment of urban waste water	190805	296.4
bottom ash and slag (from waste treatment)	190112	246.4
soil and stones	170504	239.4
animal faeces, urine and manure	20106	221.8

Unspecified	999990	211.6
minerals (from mechanical treatment)	191209	184.8
sawdust, shavings, cuttings, wood	30105	162.5
fibre rejects, fibre-, filler- and coating-sludges from mechanical separation	30310	123.6
non-ferrous waste (from shredders)	191002	112.3
non-composted fraction of municipal and similar wastes	190501	111.9
sludges from on-site effluent treatment	20204	107.8
sludges and filter cakes from gas treatment, iron industry	100214	103.8
wood from MSW	200138	99.1
unprocessed iron slag	100202	98.7
animal-tissue waste	20202	81.7
Total top 20		**5,077**

The allocation of the most important hazardous and notified non-hazardous waste exports to the different targeted waste treatment options (as defined by the waste frame works directive's R- and D-codes) is summarised in Table 25. Further more detailed data on this allocation can be found in Annex 3.

Table 25 shows that hazardous waste is exported mainly for recycling of inorganic materials and metals, as well as landfilling, while non-hazardous waste is mainly exported for being used as fuel.

Table 25: Five most important treatment options for exported hazardous and non-hazardous waste, respectively with market shares in 2007 (derived from ETC-SCP 2009)

Most important treatment options for exported hazardous waste	**R/D-Code**	**Share in %**
Recycling/reclamation of other inorganic materials	R5	22.2
Recycling/reclamation of metals and metal compounds	R4	18.9
Deposit into or onto land (e.g. landfill)	D1	13.5
Use as a fuel	R1	10.3
Incineration on land	D10	9.9
Most important treatment options for exported non-hazardous waste	**R/D-Code**	**Share in %**
Use as a fuel	R1	34.0
Recycling/reclamation of organic substances which are not used as solvents	R3	22.5
Recycling/reclamation of other inorganic materials	R5	12.6
Incineration on land	D10	9.5
Recycling/reclamation of metals and metal compounds	R4	4.5

Table 26 shows the larger hazardous waste import streams to the 27 EU Member States in the year 2007.

The data source (ETC-SCP 2009) does not give a differentiation between imports from other EU Member States and import from outside the EU

Table 26: Import of the 43 largest hazardous waste steams to 27 EU-Member States in 2007 (ETC-SCP 2009)

Waste group according to European Waste List (EWL)	EWL 6 digit number	Import in thousand tonnes (kt)
soil and stones containing dangerous substances	170503	759.4
solid wastes from gas treatment (iron industry)	100207	286.0
wastes marked as hazardous, partly stabilized	190304	249.4
lead batteries	160601	232.1
premixed wastes composed of at least one hazardous waste	190204	219.2
fly ash	190113	171.2
salt slags from secondary aluminum production	100308	141.6
glass, plastic and wood containing or contaminated with dangerous substances	170204	136.3
construction materials containing asbestos	170605	135.6
other sludges from physico/chemical treatment	191206	131.6
sludges from physico/chemical treatment containing dangerous substances	190205	120.6
mineral-based non-chlorinated engine, gear and lubricating oils	130205	104.9
filter cake from gas treatment	190105	89.2
other wastes from mechanical treatment of waste containing dangerous substances	191211	88.2
other still bottoms and reaction residues	70108	81.5
hazardous components removed from discarded electric/electronic equipment	160215	74.5
pickling acids	110105	64.9
solid wastes from gas treatment	190107	62.7
other organic solvents, washing liquids and mother liquors	70504	53.8
bilge oils from other navigation	130403	47.4
sulphuric acid and sulphurous acid	60101	46.2
oily water from oil/water separators	130507	45.7
other organic solvents and solvent mixtures	140603	42.3
slags from primary and secondary lead production	100401	39.4
halogenated still bottoms and reaction residues	70107	36.3
spent catalysts	160800	36.0
waste paint	80111	33.4
pickling bases	110107	30.0
sludges and filter cakes containing dangerous substances	110109	28.9
other organic solvents, washing liquids and mother liquors	70704	27.1
absorbents, filter materials (including oil filters not otherwise specified), wiping cloths, protective clothing contaminated by dangerous substances	150202	26.8
wastes from transport tank, storage tank and barrel cleaning	160700	21.1
insulation materials containing asbestos	170601	19.1
sludges from oil/water separators	130502	16.1
Solvents	200113	15.7
mineral based non-chlorinated hydraulic oils	130110	13.3
discarded electrical and electronic equipment other than those mentioned in 20 01 21 and 20 01 23 containing hazardous components	200135	13.3
discarded equipment containing chlorofluorocarbons	200123	12.7
discarded vehicles	160104	12.4
paint, inks, adhesives and resins containing dangerous substances	200127	11.9
fluorescent tubes and other mercury-containing waste	200121	9.4
Ni-Cd batteries	160602	3.0
mercury-containing batteries	160603	1.4
Total		**3,792**

4.5 Near future development of waste generation and prevention

4.5.1 Detailed approach

In this chapter the future development of waste generation and prevention is assessed. The methodology is developed in line with the study contract on the "preparatory study on the thematic strategy on the prevention and recycling of waste". To make an assessment of future waste generation and prevention a model has been developed based on following aspects:

- An assessment of the actual waste generation and waste composition per capita and as a whole, with attention to the distinctive dynamism for municipal and household waste and for industrial waste.
- An assessment of the actual demography and its foreseen evolution over 20 years
- An assessment of the evolution in the GDP or other relevant indicators for the foreseen economic evolutions
- An interpretation of the empirical graphs of Kuznetz on the relation between economic growth and environmental impact.
- An assessment of the degree of decoupling: negative decoupling, coupling, relative decoupling, absolute decoupling that can be expected for the European Union and its Member States.
- An assessment of actual and planned waste and waste prevention policy

The assessment is built up on homogeneous groups with comparable characteristics and at the end counted together in a rational way to make an estimate for the whole of the European Union.

4.5.2 Results

We lack space to copy in the frame of this study all parameters and results retrieved for the exercise on the "Development of quantitative future projections" as performed in the frame of the study "Preparatory Study for the Review of the Thematic Strategy on the Prevention and Recycling of Waste" (in preparation).

Major aspects of the methodology are summarised.

4.5.2.1 Basic assumptions

Projections into the future primarily made with following basic assumptions:

- No additional strategies or actions at EU level are put into place. Planned but not yet fully concretised strategies, like waste prevention and decoupling targets to be set for 2020, according to article 9 (c) of the Waste Framework Directive, will be taken into account with utmost care.
- Any actions currently underway are implemented fully. All legally binding targets are reached at the foreseen timescale. Especially recycling targets for specific fractions and the landfill diversion targets for biodegradable wastes have to be taken into account. This means that the projections are no business-as-usual scenario, because it cannot be read from the actual data that all Member States will reach all targets fully and within the foreseen timing. Supplementary policy actions at local or Community level might be necessary to reach these targets. This may request for specific Member

States a considerable and persistent effort on developing alternatives for waste treatment practices.

- Longer term predictions are confronted with increasing degrees of uncertainty on external parameters, like economic or demographic evolutions, social or cultural shifts, evolutions in technology and evolutions in both domestic and Community environmental policy. Predictions could only be made to the extent that these are reasonably possible to estimate.

4.5.2.2 Member States aggregated in more homogeneous groups

The quantitative assessment has been realised on three groups of more or less comparable member States, named as the yellow, turquoise and lavender group. This division is a proxy of reality, representing the general characteristics of a group of countries, but disregarding exemptions or special cases. The division has been made based on following set of parameters:

Low GDP per capita – high GDP per capita

Affects the consumption patterns and the generation of waste per capita

Fast growing economies – stabilised economies

Affects the growing rate of waste generation and the degree of decoupling. Three levels can be observed; negative decoupling associated with very fast growth, no decoupling associated with rather fast growth, relative decoupling associated with moderate growth.

Traditional environmental acquis States – recent or emerging acquis States

Relates to the quantity and the quality of available waste treatment infrastructure. A clear indicator can be the exemption that is granted for the landfill directive targets on landfilling biodegradable waste.

Assessment of reaching landfill diversion targets

Based on the EEA study "projections of municipal waste management and greenhouse gases, member States can be divided in four groups : A complying with all stages, B complying with the first two but failing the third (35%) stage, C complying only with the first target (75%), D not complying with any targets. This could be used as an alternative indicator for European acquis.[56]

Applied waste treatment strategies

Linking groups to shared waste policies could be valuable[57]. ETC SCP has divided Member States in three categories; A > 25% incineration and >25% material recovery, B < 25% incineration and > 25% material recovery, C < 25% incineration and < 25% material recovery.[58]

EU-15 states – EU12-states

Overlaps, but not completely, with some of the above mentioned categories

Northern states – southern states

Northern states are in need of energy sources, southern states are in need of compost and soil depletion remedies

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[56] EEA ETCSCP personal communication 18/06/2010 and ETCSCP "Projections of municipal waste management and greenhouse gases", draft April 2010

[57] EEA ETCSCP personal communication on 18/06/2010 and WRAP personal communication 07/07/2010

[58] Other categorisation could be useful as well, like the cost of sending waste to landfill normalized against GDP (WRAP),

Table 27: Categorising Member States in three groups

Member State	GDP/capita (2007)	GDP growth rate (2007)	landfill directive target year	municipal waste arising per capita	GDP/capita top (t), middle (m), low (l) based on 33% and 66% percentile	GDP growth moderate (M), fast (F), very fast (VF)	acquis state traditional (T), emerging (E)	Landfill Directive compliancy according to ETC SCP	shared waste policies according to ETC SCP	municipal waste arising/capita top (t), middle (m), low (l) based on 33% and 66% percentile	EU-15 or EU-12	northern (N) or southern (S)
	data				classification							
Bulgaria	37,7	6,2	2020	475	l	VF	E	C	C	m	EU-12	S
Romania	41,6	6,3	2020	377	l	VF	E	D	C	l	EU-12	S
Poland	54,4	6,8	2020	319	l	VF	E	D	C	l	EU-12	N
Latvia	55,7	10	2020	310	l	VF	E	D	B	l	EU-12	N
Lithuania	59,3	9,8	2020	376	l	VF	E	B	C	l	EU-12	N
Hungary	62,6	1	2016	460	l	M	T	C	C	m	EU-12	N
Slovakia	67,7	10,6	2020	289	l	VF	E	D	C	l	EU-12	N
Estonia	68,8	7,2	2020	436	l	VF	E	C	B	l	EU-12	N
Portugal	75,6	1,9	2016	446	l	M	T	C	C	m	EU-15	S
Malta	76,5	3,8	2020	624	m	F	E	D	B	t	EU-12	S
Czech Republic	80,1	6,1	2020	289	m	VF	E	D	C	l	EU-12	N
Slovenia	88,6	6,8	2016	423	m	VF	T	B	A	l	EU-12	S
Greece	92,8	4,5	2020	438	m	F	E	D	C	l	EU-15	S
Cyprus	93,6	5,1	2020	739	m	VF	E	D	C	t	EU-12	S
Italy	103,5	1,5	2016	542	m	M	T	D	B	m	EU-15	S
Spain	105	3,6	2016	597	m	F	T	C	B	t	EU-15	S
France	108,5	2,3	2016	532	m	M	T	A	A	m	EU-15	S
Belgium	115,7	2,9	2016	481	m	M	T	A	A	m	EU-15	N
Germany	115,8	2,5	2016	564	t	M	T	A	A	m	EU-15	N
United Kingdom	116,7	2,6	2020	585	t	M	E	C	B	t	EU-15	N
Finland	117,9	4,9	2016	479	t	F	T	C	B	m	EU-15	N
Denmark	121,3	1,7	2016	737	t	M	T	A	A	t	EU-15	N
Sweden	122,8	2,5	2016	482	t	M	T	A	A	m	EU-15	N
Austria	123	3,5	2016	620	t	M	T	A	A	t	EU-15	N
Netherlands	132,2	3,6	2016	624	t	F	T	A	A	t	EU-15	N
Ireland	148,1	6	2020	740	t	VF	E	D	B	t	EU-15	N
Luxembourg (Gra	275,2	6,5	2016	678	t	VF	T	A	A	t	EU-15	N

All data are retrieved for the year 2007, the most recent year without conjuncture distortion

- The GDP per capita is expressed in Purchasing Power Standards (PPS) (EU-27 = 100)
- The growth rate is expressed in GDP volume - percentage change on previous year
- The landfill directive target year refers to the year in which, according to article 5.2 of the landfill Directive 1999/31/EC only 35% (weight) of the biodegradable waste generated in 1995 may be landfilled. It could be an (imperfect) indicator for the degree in which the Member State already has developed alternative waste treatment capacity in line with the European acquis.

Countries can be divided in following categories:

- Top, middle and low scoring countries on the parameter GDP/capita, with a top scorer is above the 66% median value, a middle scorer is above 33% median value and a low scorer is below the 33% median value.

- The growth speed can be marked as very fast VF if above 5%/year, fast F is above 3.5%/year and moderate M if below 3,5%/year
- Traditional acquis-states T have no problem in reaching the landfill directive target, emerging acquis-states E have requested more time to develop their infrastructure.
- Classifications for reaching Landfill Directive targets or applying comparable policy strategies are retrieved from ETC SCP.
- The division between northern and southern states is rather arbitrarily made, especially for border countries like France or Hungary.

Yellow countries are predominantly very fast evolving economies, with still a low GDP/capita. They are all EU-12 Member States. They are characterised with a negative decoupling of waste and with a predominantly poorly established waste treatment and recycling capacity. They usually have a low MSW generation per capita and have difficulties reaching the landfill diversion targets.

Turquoise countries are predominantly southern countries both from EU-12 and EU-15 (Greece, Portugal) with a moderate GDP/capita. They are characterised with an emerging waste treatment and recycling capacity which is still not fully developed. They have fast to very fast growing economies, but less pronounced than the yellow countries. They have difficulties in reaching the landfill diversion targets and have a moderate to low generation of MSW per capita

Lavender countries all are EU-15 countries with a moderate to high GDP/capita. With some exceptions there growth is predominantly moderate. They tend to evolve towards relative decoupling for municipal waste, and have a fully developed waste treatment and recycling patrimony, except for Ireland and the UK that have some delay. Still some member States struggle with the landfill directive targets, but most cope with them, based on a waste treatment policy based on material recovery added with incineration although some Member States have expander d their waste incineration capacity more than others. Lavender states are a mixture of northern and southern countries.

4.5.2.3 Modelling

The definition of the trend assessment passes through following stages:

- Inventory of available basic quantitative data, and assessment of lacking information.
- Classification of the Member State group on its average stage in a typical waste policy development chain, e.g. its position on the Kuznetz curve, its degree of decoupling.
- Assessment of the presumed generation of municipal solid waste and other waste between 2000-2005 and 2030.
- Assessment of changes in waste collection and waste treatment based on available policy information, like planned investments, preferences for treatment options assessed…
- Assessment of export of waste trends
- Assessment of waste treatment capacities needed in future.

The amount of waste generated is mainly proportional to the population, the economic growth as expressed by the GDP, and the degree of decoupling. In addition, other factors may affect the amount and composition of waste or the applied collection and treatment methods. These are climate, living habits, level of education, religious and cultural beliefs, and social and public attitudes. These aspects are taken into account when collecting the start set of data and the future evolution in collection coverage, preferred treatment (e.g. energy applications, composting, material recycling) operation, degree of source separated collection, etc…

The modelling is build upon following aspects and assumptions:

- The use of the GDP as an indicator for economic growth and production and consumption patterns. GDP is not the best possible indicator, but the largest available indicator for which future calculations have been made. It is not the scope to assess progress, wealth or well-being, but merely economic production that is linked to waste generation.
- A linear relationship between the total amount of municipal solid waste (MSW) and the demographic evolution
- An evolution in the composition of municipal solid waste in line with changing consumption patterns, social and cultural changes and the GDP
- Partial application of the Kuznetz assumption that economic growth reduces the environmental impact of economic activity. For MSW it can be empirically observed that generation per capita reaches a maximum and stabilises at a certain level in line with economic growth. The second half of the Kuznets curve, with diminishing impacts, has not been observed in the field of MSW generation.

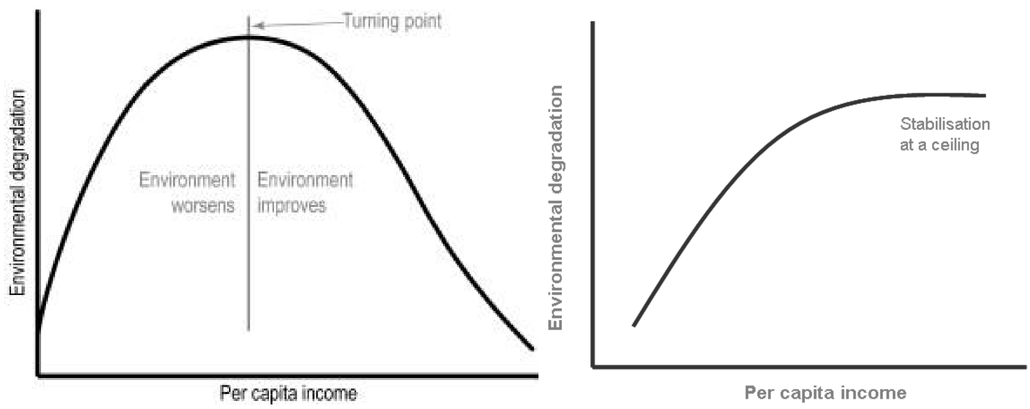


Figure 33: Original and adapted Kuznetz curves

- No linear relation between MSW generation and GDP, but an assessment of the degree of coupling or decoupling of the waste generation and GDP, using the OECD terminology:
  - negative decoupling or waste volumes increasing at a higher rate than the economy. This can be assumed for yellow countries, where in a first phase due to quick economic growth and a catch up operation in a context with less environmental awareness or pressure, a negative decoupling takes place and waste generation grows more quickly than the economy. This first phase is followed by stabilisation.

- coupling or non-decoupling where waste (MSW and industrial waste) volumes increase at the same rate of the growth of the GDP. This can be assumed for turquoise countries
- relative decoupling where waste volumes still grow but at a lower rate than the GDP. This can be assumed for lavender countries. The MSW generation is decoupled from the economic growth and municipal solid waste tends to stabilise around a maximum value. The only factor influencing the waste quantity is the demographic growth. The total industrial (or non-household) waste generation will evolve towards a growth rate lower than the economic growth rate. It cannot be expected to reach a ceiling.
- absolute decoupling where waste volumes decrease (in theory) while GDP grows. This has not been observed yet.

- An evolution of the non-MSW (i.e. industrial waste, commercial waste, other non household waste streams) depending on the GDP but not on the demography.
- Municipal solid waste volumes are assumed to grow initially to a top level, as happened in EU-15 Member States, and subsequently to stabilise. Industrial (or non-MSW) waste volumes are assumed to continue growing as economic growth is dependent on increasing material use for quite a while.

4.5.2.4 Basic data

Basic data that are applied in the modelling are, for each defined group of Member States:

- The actual composition of municipal solid waste, based on sorting exercises and/or amounts of source separated collected waste fractions. The minimal used composition data divide the MSW generated in glass, metals, plastics, paper, bio-waste and other waste fractions.

Table 28: Composition of MSW (%) in specified groups of Member States

	lavender	turquoise	yellow
bio-waste	36	36	33
paper and cardboard	18	17	10
plastics	6	7	9
glass	6	4	8
metals	2	4	2
textiles	2	3	4
inert	14	17	21
other	16	12	13
	100	100	100

- The actual average generation of MSW per capita

Table 29: Average generation of MSW per capita (kg/inh) in specified groups of Member States

weighed average: kg/inh

	2000	2005
yellow	356	364
turquoise	418	405
lavender	577	565

- The total generation of non-MSW waste

Table 30: Total generation of non-MSW waste (1000 tonnes) in specified groups of Member States

other waste
1000 ton

	2005
yellow	889.979
turquoise	100.569
lavender	1.688.728

- The total collection of construction and demolition waste

Table 31 : Total collection of construction and demolition waste (1000 tonnes) in specified groups of Member States

total 1000 ton
taking into account average values
where real values are missing

	C&D waste	WWT sludge
yellow	14.643	3.399
turquoise	20.147	2.119
lavender	795.162	8.519

% of total non-household waste

	C&D waste	WWT sludge
yellow	1,65	0,38
turquoise	20,03	2,11
lavender	47,09	0,50

- The actual population and anticipated population growth waste in specified groups of Member States

Table 32 : Actual population and anticipated population growth

observed	yellow	turquoise	lavender
assessed	population		
2000	92.186.081	34.435.322	356.146.307
2001	91.631.172	34.533.468	357.632.578
2002	90.703.175	34.598.690	359.334.882
2003	90.508.747	34.724.577	361.414.507
2004	90.316.057	34.853.457	363.630.087
2005	90.155.051	34.982.016	366.016.577
2006	89.994.337	35.120.628	368.111.971
2007	89.838.276	35.254.895	370.212.253
2008	89.709.091	35.422.318	372.514.046
2009	89.466.298	35.552.851	372.424.633
2010	89.338.748	35.692.543	374.358.089
2011	89.208.958	35.824.845	376.182.141
2012	89.091.233	35.953.226	377.930.278
2013	88.976.397	36.073.090	379.598.754
2014	88.860.915	36.182.485	381.189.683
2015	88.742.627	36.281.433	382.702.676
2016	88.616.122	36.373.325	384.138.008
2017	88.478.698	36.455.295	385.500.388
2018	88.330.144	36.527.986	386.799.277
2019	88.166.719	36.591.466	388.030.443
2020	87.988.874	36.646.909	389.201.849
2021	87.794.870	36.694.836	390.313.952
2022	87.579.482	36.734.389	391.368.561
2023	87.342.652	36.766.242	392.365.064
2024	87.085.875	36.790.571	393.303.405
2025	86.807.356	36.808.384	394.195.104
2026	86.509.718	36.822.813	395.036.019
2027	86.191.464	36.830.930	395.831.449
2028	85.855.227	36.835.194	396.580.234
2029	85.505.491	36.837.047	397.290.215
2030	85.142.888	36.837.004	397.962.187

- The actual and anticipated economic development in GDP

Table 33: Actual and anticipated economic development in GDP (000Meuro '00) in specified groups of Member States

	1990	2000	2010	2020	2030
yellow	315	356	529	777	1.058
turquoise	272	333	473	651	870
lavender	6.786	8.298	10.513	13.161	16.264

- The actual collection coverage for MSW (with coverage being defined as a percentage of the population that has collection service)

Table 34: Actual collection coverage for MSW (%) of served population

yellow	0,854
turquoise	0,975
lavender	0,998

- The actually applied treatment methods for waste fractions

Table 35: Treatment of MSW (kg/inh) in specified groups of Member States

weighed average available values

	glass recycling kg./inh	plastic recycling kg/inh	paper card rec. kg/inh	metals recycling kg/inh	total recycling kg/inh	incineration kg/inh	landfill kg/inh
yellow	4,74	2,50	12,82	2,73	61,20	11,84	324,09
turquoise	9,08	3,70	26,91	5,14	62,93	5,17	386,79
lavender	29,90	18,35	67,01	7,97	232,67	132,52	199,91

Table 36: Treatment of bio-waste in MSW (%) in specified groups of Member States

weighed average values

	% in total MSW	% of biowaste recycled	recycled kg/inh	composted kg/inh	composted kg/inh	AD kg/inh
yellow	36,03	12,39	16,56	13,65	2,90	0,00
turquoise	37,44	1,39	2,32	1,90	0,00	0,42
lavender	37,37	28,07	58,40	51,36	1,91	4,92

Table 37: Treatment of total waste (%) in specified groups of Member States

	% reuse recycling	% incineration	%landfill
yellow	25,17	0,88	73,95
turquoise	38,17	3,77	58,06
lavender	53,59	6,76	39,65

Table 38: Recycling of total waste fractions (1000 tonnes) in specified groups of Member States

recycling of total waste	metals	glass	plastics	paper
yellow	12.771	866	800	1.290
turquoise	7.514	465	357	1.828
lavender	38.724	7.495	3.877	26.253

Table 39: Treatment of inert waste (%) in specified groups of Member States

- Exports to non OECD countries are assessed as follows:
  - In line with worldwide trends it is to be expected that for the first forthcoming years export of waste will increase with about 10%/year.

- Glass waste is exported for 12%
- Paper waste is exported for 30%
- Metal waste is exported for 32%.
- Plastics waste for an unknown but presumably very high amount. Due to lacking information, we have to assume 75% as a probably conservative estimate.
- At EU-27 level in 2006, almost 45% of all paper waste export is directed to non EU-countries. In 2009 this is 56%.
- At EU-27 level in 2006, 68% of all plastic waste export is directed to non EU-countries. In 2009 this is 73%.
- At EU-27 level in 2006, 25% of all metal waste export is directed to non EU-countries. In 2009 this is 38%.
- At EU-27 level in 2006, 14% of all glass waste export is directed to non EU-countries. In 2009 this is 10%

4.5.2.5 Results

European data are compiled by making a sum of the modelled outcomes for the yellow, turquoise and lavender groups. Quantitative data for each subgroup and for the total are added in Annex 5.

4.5.2.5.1 Municipal Solid Waste

The total generation of MSW will increase slowly after a phase of more intense increase until 2016, driven by both demographic and economic changes. The average generation per capita tends to reach a maximum in 2016. From that year on the demographic evolution will be the major driving force.

Unlike specific groups, as the yellow group of Member States, the average composition of generated municipal solid waste will remain rather stable at the level of EU-27. Mind the dimension in the value axis in Figure 34. The values represented do not indicate the degree of (source separated) collection of these fractions but merely its generation. These fractions may end up either in the mixed waste or in the sorted out waste.

Landfill will drop mainly driven by the evolutions in the lavender group of countries and the assumed compliance with the Landfill Directive targets. Incineration will rise and stabilise from 2018 onwards.

Recycling of MSW fractions trends to stabilise after a shorter period of continued increase, driven by the recycling targets for specific waste streams. Composting however affects a larger fraction of generated MSW and trends to increase considerable as a cheap and effective method for landfill diversion of MSW. AD becomes more important as a source of green energy.

Figure 34: Generation of municipal solid waste in EU-27 2006-2030

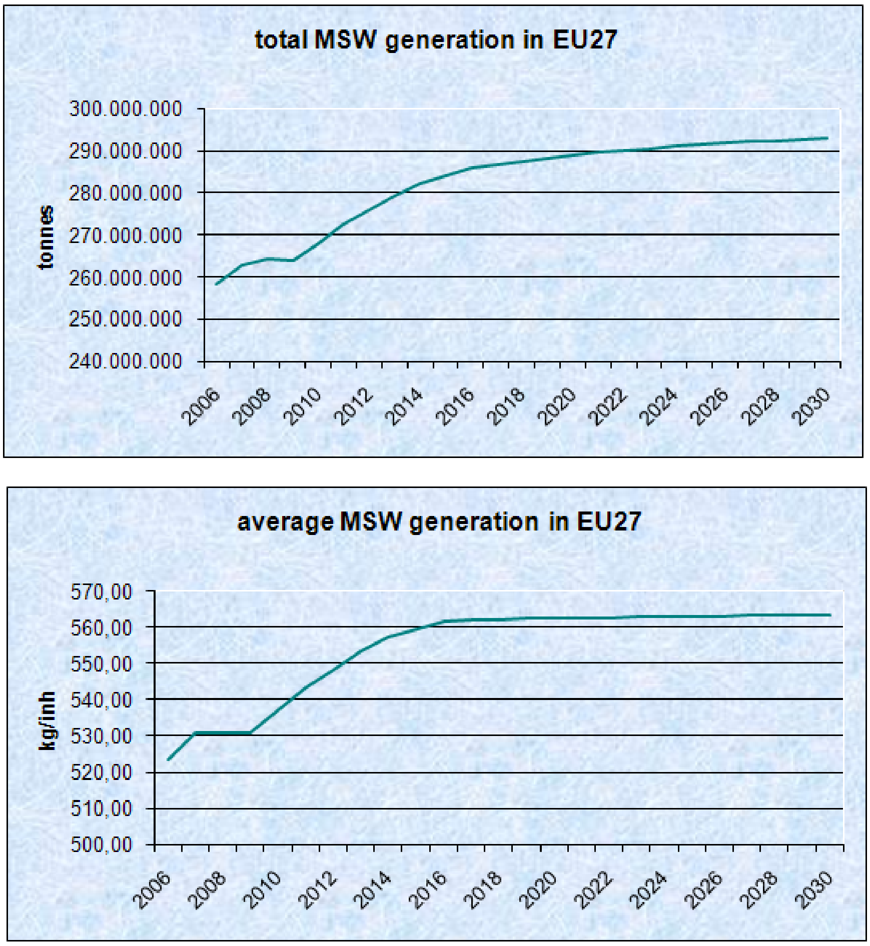


Figure 35: Average composition of MSW between 2005-2030

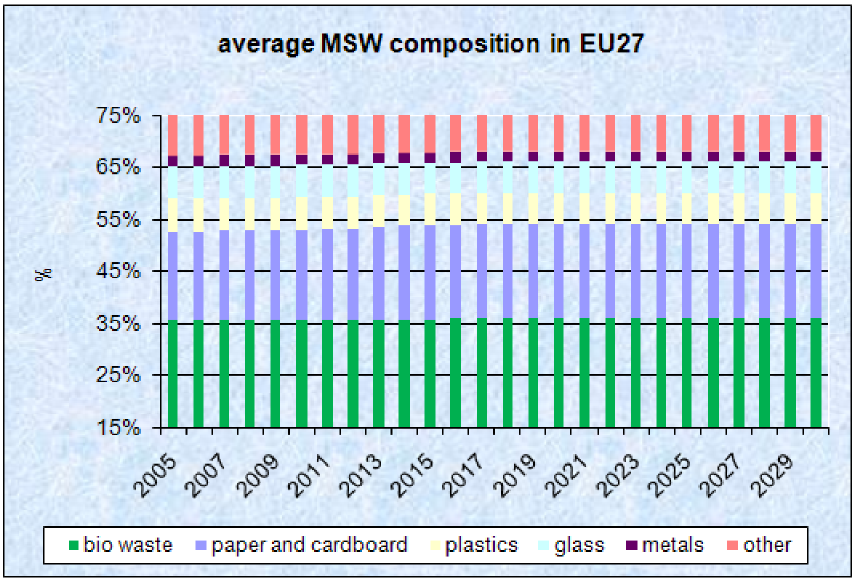


Figure 36: Total MSW generation split up in fractions, between 2005-2030

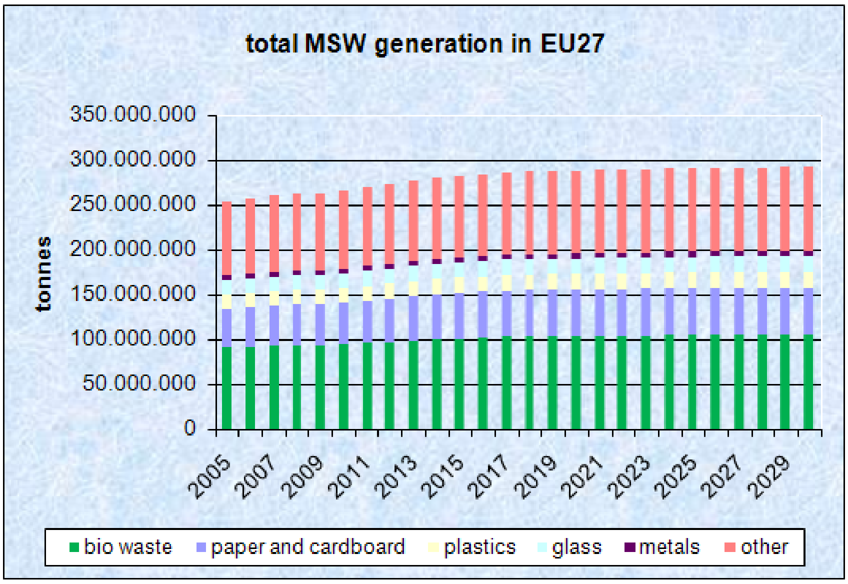


Figure 37: Landfilled MSW between 2005-2030

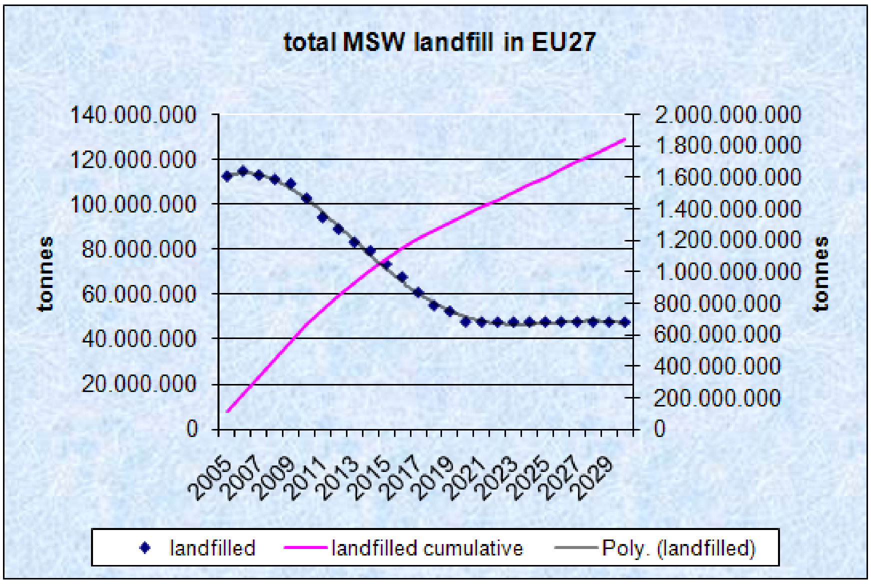


Figure 38: Incinerated MSW between 2005-2030

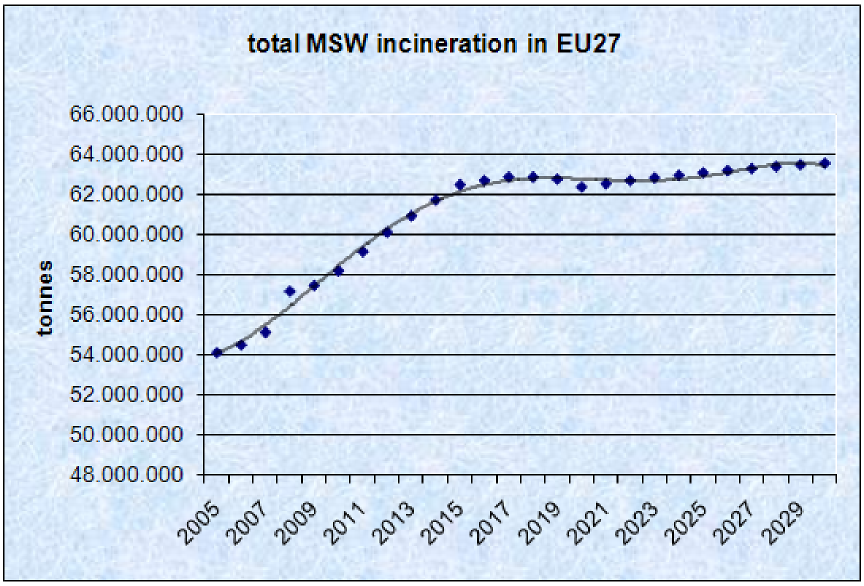


Figure 39: Recycling of different fractions of MSW between 2005-2030

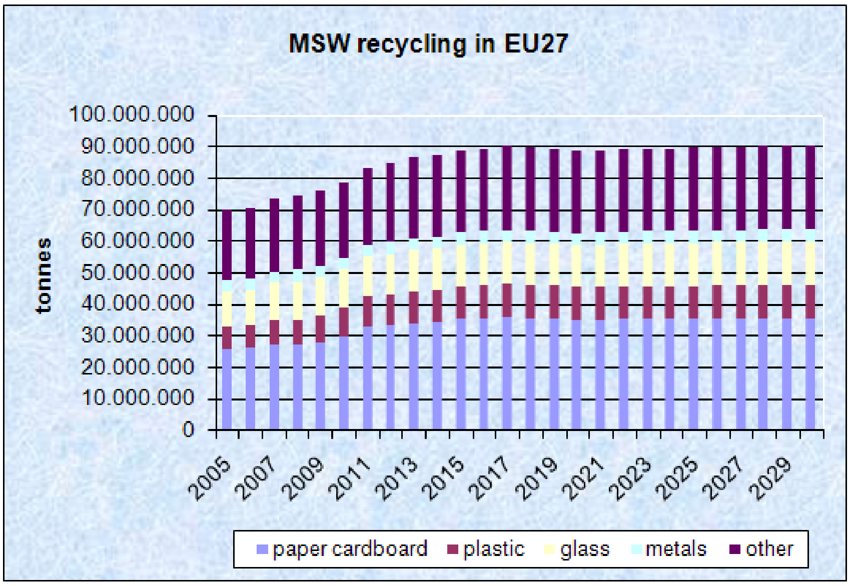
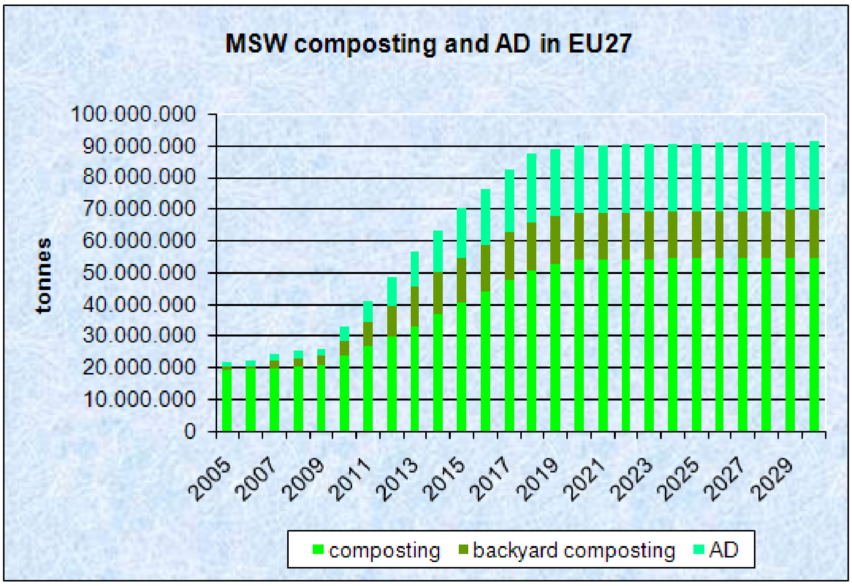


Figure 40: Composting and AD of the bio-waste fraction in MSW between 2005-2030



4.5.2.5.2 Industrial and other non household waste

Industrial and the sum of all other non-household waste streams have the tendency to increase, following a rather stable path. It is important to keep in mind that industrial and non-household waste represents a far larger waste fraction than MSW.

Industrial waste is split up in thousands of different waste streams, all with individual properties. For the sake of this exercise two assumed large and homogeneous fractions have been analysed. Inert waste as a proxy for construction and demolition waste, and waste water treatment sludge. Although in quantitative figures the generation of waste water treatment sludge is quite considerate, it nearly does not form a perceivable part of the total quantity of generated waste. Inert waste becomes more and more visible in the reported statistics, which does not mean that it grows at the same speed, but that it is better collected and kept out of the fraction of mixed waste. C&D waste forms an important fraction of the total generated industrial and non household waste.

Although recycling of inert waste and C&D waste becomes increasingly important, landfill of these fractions on e.g. dedicated landfill sites will remain important in EU-27 for the non recycled fraction of 30% or less of the generated C&D waste. Landfill of other industrial waste fractions tends to decrease, also in line with the shift described above.

Incineration of industrial waste increases until 2016 and then stabilises, although the total waste generation keeps increasing.

Due to the large variety of waste streams generated in industry, trade, services, waste treatment the fractions of reported plastics, paper, metals and glass are rather limited compared to all other reported waste streams. Often these fractions are still mixed up with the mixed industrial waste, or are components of otherwise reported waste streams that are split off only at a later stage. The graph in Figure 42 therefore only shows a partial image. Other recycling included e.g. recycling of inert waste or biodegradable waste, but also recycling of paper, glass, metals, plastics in differently named waste streams. Recycling is characterised by an over all and continued increase.

Export of waste to non-EU-27 countries keeps increasing in line with the actual trends, that are taken over by the EU-12 Member States, the increasing availability of recyclable non hazardous ‘green listed’ waste fractions, and the increasing demand for raw materials in the growing economies.

Figure 41: Total generation of industrial and non-household waste between 2006-2030

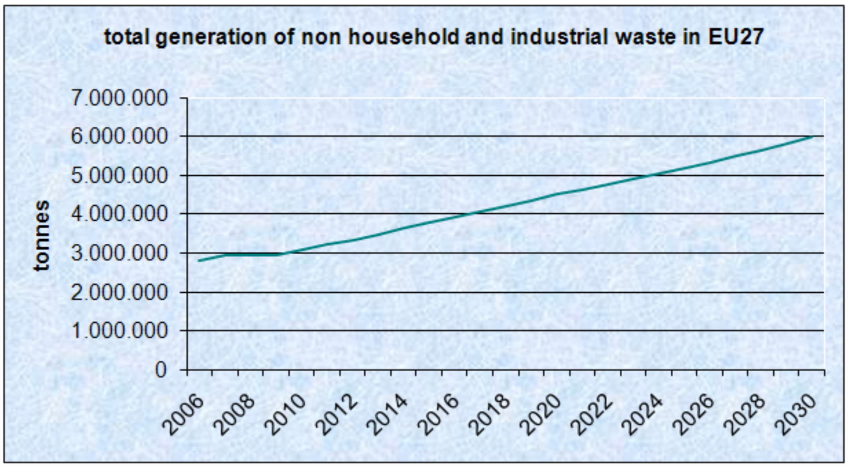


Figure 42: Average industrial and non household waste composition between 2005-2030

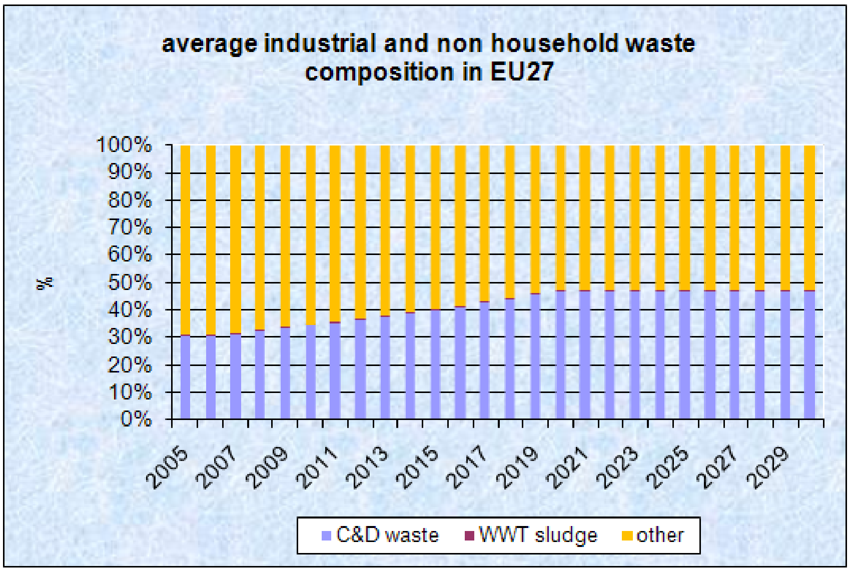


Figure 43: Generation and collection of industrial and non household waste fractions between 2005-2030

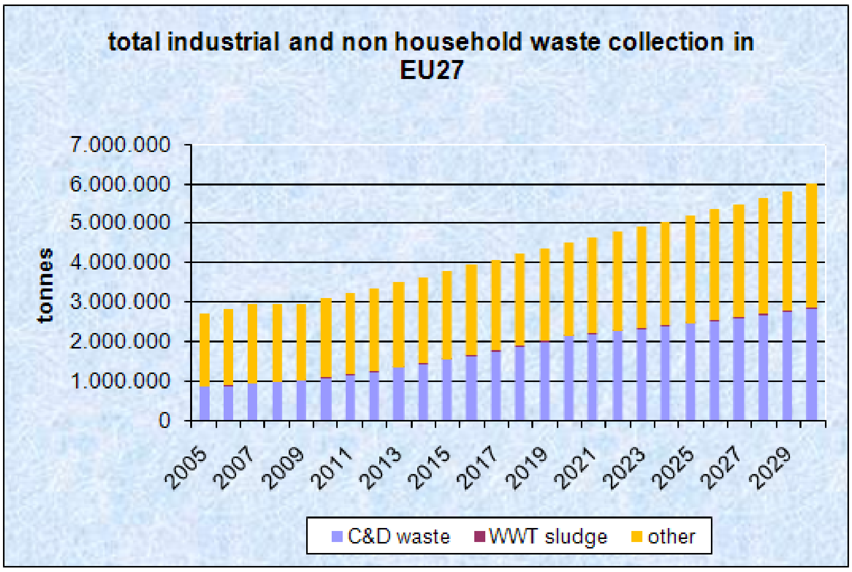


Figure 44: Landfill of industrial and non household waste between 2005-2030

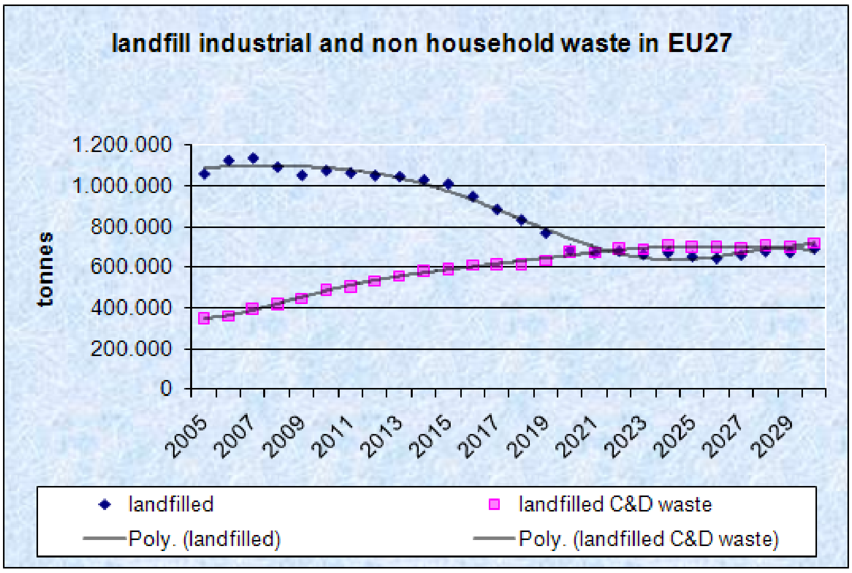


Figure 45: Incineration of industrial and non household waste between 2005-2030

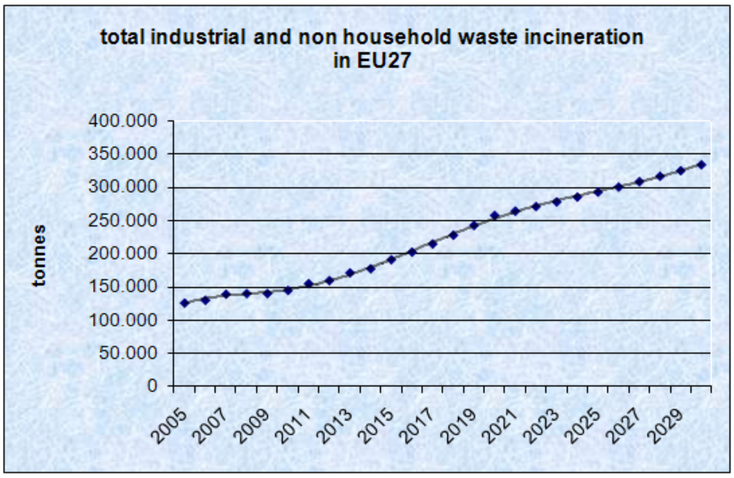
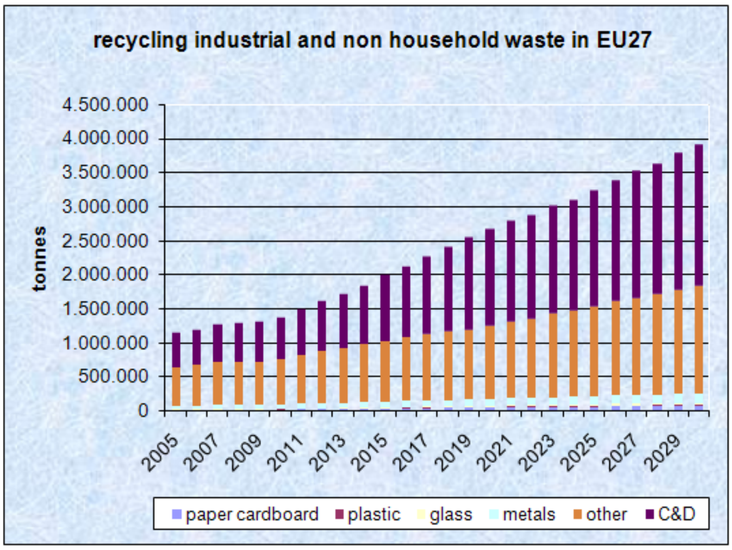


Figure 46: Recycling of industrial and non household waste fractions between 2005-2030



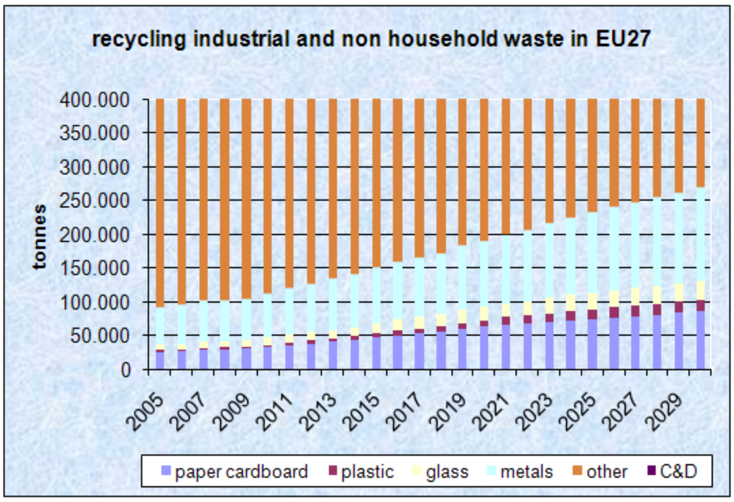
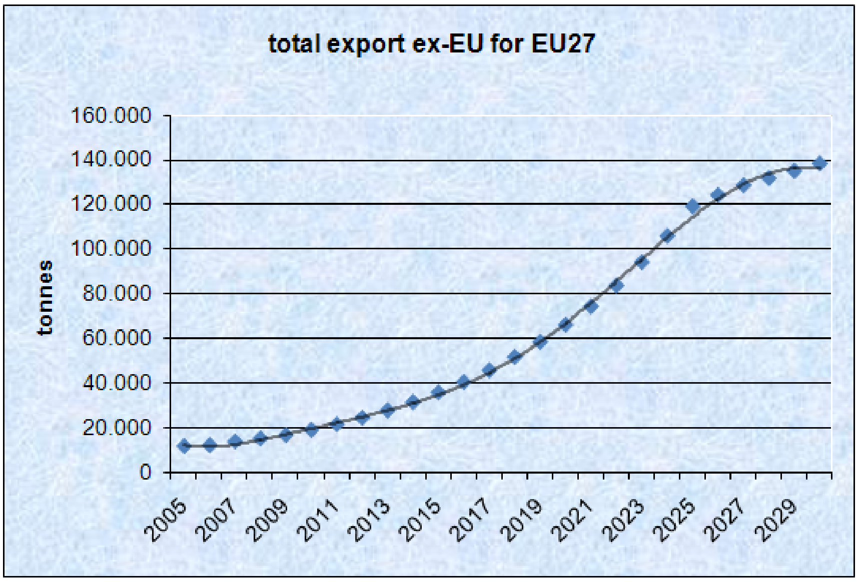


Figure 47: Export of industrial and non-household waste to non EU-countries between 2005-2030



4.6 Material flows in the economy

4.6.1 Detailed approach

In this chapter a clear overview is established of material flows to the economy in order to identify how much material is generated, treated and disposed of, and to what extent this use can be prevented. The EU material flows are quantitatively described with emphasis of the material flows of domestic extraction, imports and exports. This is complemented as far as possible by material flows within the EU economy.

The focus lies on the main material streams including metals, paper, glass, plastics, bio-waste and minerals.

Data collection is based on chapter 4.3. Data from existing environmentally extended input-output tables is used as a primary data source. The collected data is transferred to an excel-spread sheet and described in the same format as the waste flows described under chapter 4.4.

Attention is paid to changing trends in material flows. Due to new technologies and new production and consumption patterns, for some major materials (e.g. plastics) considerate changes can occur.

In the year 2007 EUROSTAT issued questionnaires to the EU-Member-States asking for Economy-Wide Material Flow Account (EW-MFA) data, disaggregated into some 50 material categories (see Table 40). Till early 2009 most Member States provided data on domestic extraction, material imports and exports for the years 2000 to 2005. In order to get a complete data set for the period 2000 to 2005 data gaps were filled by taking the value of the preceding year. Only few Member States up to early 2009 also submitted data for the year 2006. Here the data gaps are too big to be filled.

The questionnaire asked for “Waste imported/exported for final treatment and disposal”. Most Member States did not report any such waste imports, so other sources (e.g.[59]) show that such imports exist. Therefore “Waste imported/exported for final treatment and disposal” is ignored in the tables and graphics shown in chapter 4.6.2.

The data reported by the Member States were summed up to give the data set for EU-27 as a whole. Only 11 Member States had reported imports differentiated by source (from inside / from outside the EU). In order to get the total import into the EU area, however, only imports from outside the EU. In order to estimate this value following formula was used:

$$import_{EU\,27} = \frac{import_{\sum(11\,MS\ import\ extra\ EU)} * import_{\sum(27\,MS\ import\ intra+extra\ EU)}}{\left(import_{\sum(11\,MS\ import\ intra\ EU)} + import_{\sum(11\,MS\ import\ extra\ EU)}\right)}$$

Equation 2: Estimation of Imports from rest of world to EU-27

with:

Import $_{EU27}$	imports to EU27 from outside the EU
Import_$_{Sum(11\ MS\ import\ extra\ EU)}$	sum of the imports from outside the EU which have been reported by 11 Member States
Import_$_{Sum(27\ MS\ import\ intra\ +\ extra\ EU)}$	sum of the imports from within plus from outside the EU as reported by all 27 Member States
Import_$_{Sum(11\ MS\ import\ intra\ EU)}$)	sum of the imports from within the EU which have been reported by 11 Member States

The same procedure was used to estimate the material exports from the EU to the rest of the world.

Table 40: Material flow categories as defined by EUROSTAT in the questionnaires on Economy-Wide Material Flow Account (EW-MFA) (EUROSTAT)

Defined for Domestic Extraction	**Defined for imports/exports**
A.1 Biomass	**B.1 Biomass and biomass products**
A.1.1 Primary crops	B.1.1 primary crops
A.1.1.1 Cereals	B.1.1.1 Cereals, primary and processed
A.1.1.2 Roots, tubers	B.1.1.2 Roots and tubers, primary and processed
A.1.1.3 Sugar crops	B.1.1.3 Sugar crops, primary and processed
A.1.1.4 Pulses	B.1.1.4 Pulses, primary and processed
A.1.1.5 Nuts	B.1.1.5 Nuts, primary and processed
A.1.1.6 Oil bearing crops	B.1.1.6 Oil bearing crops, primary and processed
A.1.1.7 Vegetables	B.1.1.7 Vegetables, primary and processed
A.1.1.8 Fruits	B.1.1.8 Fruits, primary and processed
A.1.1.9 Fibres	B.1.1.9 Fibres, primary and processed
A.1.1.10 Other crops (Spices Stimulant crops,	B.1.1.10 Other crops (Spices Stimulant crops,

[59] ETC-RWM (2008): Transboundary shipment of waste in the EU - Development 1995-2005 and possible drivers. Technical Report 2008/1, Copenhagen.

Defined for Domestic Extraction	Defined for imports/exports
Tobacco, Rubber and other crops)	Tobacco, Rubber and other crops), primary and processed
A.1.2 Crop residues (used)	B.1.2 Crop residues
A.1.2.1 Straw	B.1.2.1 n.a.
A.1.2.2 Other crop residues (sugar and fodder beet leaves, other)	B.1.2.2 Other crop residues (sugar and fodder beet leaves, other)
A.1.3 Fodder crops incl grassland harvest	B.1.3 Fodder crops incl grassland harvest
A.1.3.1 Fodder crops	B.1.3.1 Fodder crops
A.1.3.2 Biomass harvested from grassland	B.1.3.2 Biomass harvested from grassland
A.1.4 Grazed biomass	B.1.4 n.a.
A.1.5 Wood	B.1.5 Wood primary and processed
A.1.5.1 Timber (Industrial roundwood)	B.1.5.1 Timber, primary and processed
A.1.5.2 Wood fuel and other extraction	B.1.5.2 Wood fuel and other extraction, primary and processed
A.1.6 Fish capture, crustaceans, molluscs and aquatic invertebrates	B.1.6 Fish capture, crustaceans, molluscs and aquatic invertebrates primary and processed
A.1.7 Hunting and gathering	B.1.7 n.a.
	B.1.8 Live animals other than in B 1.6., meat and meat products
	B.1.8.1 Live animals other than in B 1.6.
	B.1.8.2 Meat and meat preparations
	B.1.8.3 Dairy products, birds eggs, and honey
	B.1.8.4 Other products from animals (animal fibres, skins, furs, leather etc.)
	B.1.9 Products mainly from biomass
A.2 Metal ores (gross ores)	**B.2 Metal ores and concentrates, processed metals**
A.2.1 Iron ores	B.2.1 Iron ores and concentrates, iron and steel
A.2.2 Non ferrous metal ores	B.2.2 non ferrous metal ores and concentrates, processed metals
A.2.2.1.a Copper ores gross ore	B.2.2.1 Copper
A.2.2.1.b Copper ores metal content	
A.2.2.2.a Nickel ores gross ore	B.2.2.2 Nickel
A.2.2.2.b Nickel ores metal content	
A.2.2.3.a Lead ores gross ore	B.2.2.3 Lead
A.2.2.3.b Lead ores metal content	
A.2.2.4.a Zinc ores gross ore	B.2.2.4 Zinc
A.2.2.4.b Zinc ores metal content	
A.2.2.5.a Tin ores gross ore	B.2.2.5 Tin
A.2.2.5.b Tin ores metal content	
A.2.2.6.a Gold, silver, platinum and other precious metal ores gross ore	B.2.2.6 Gold, silver, platinum and other precious metals
A.2.2.6.b Gold, silver, platinum and other precious metal ores metal content	
A.2.2.7.a Bauxite and other aluminium ores gross ore	B.2.2.7 Aluminium
A.2.2.7.b Bauxite and other aluminium ores metal content	
A.2.2.8.a Uranium and thorium ores gross ore	B.2.2.8 Uranium and thorium
A.2.2.8.b Uranium and thorium ores metal content	
A.2.2.9.a Other metal ores gross ore	B.2.2.9 Other metals
A.2.2.9.b Other metal ores metal content	
	B.2.3 Products mainly from metals
A.3 Non metalic minerals	**B.3 Non metalic minerals primary and processed**
A.3.1 Ornamental or building stone	B.3.1 Ornamental or building stone
A.3.2 Limestone, gypsum, chalk, and dolomite	B.3.2 Limestone, gypsum, chalk, and dolomite
A.3.3 Slate	B.3.3 Slate

Defined for Domestic Extraction	Defined for imports/exports
A.3.4 Gravel and sand	B.3.4 Gravel and sand
A.3.5 Clays and kaolin	B.3.5 Clays and kaolin
A.3.6 Chemical and fertilizer minerals	B.3.6 Chemical and fertilizer minerals
A.3.7 Salt	B.3.7 Salt
A.3.8 Other mining and quarrying products n.e.c.	B.3.8 Other mining and quarrying products n.e.c.
A.3.9 Excavated soil, only if used (e.g for construction work)	B.3.9 Excavated soil, only if used (e.g for construction work)
	B.3.10 Products mainly from non metalic minerals
A.4 Fossil energy carriers	**B.4 Fossil energy carriers, primary and processed**
A.4.1 Brown coal incl. oil shale and tar sands	B.4.1 Brown coal incl. oil shale and tar sands
A.4.2 Hard coal	B.4.2 Hard coal
A.4.3 Petroleum	B.4.3 Petroleum
A.4.4 Natural gas	B.4.4 Natural gas
A.4.5 Peat	B.4.5 Peat
	B.4.6 Products mainly from fossil energy carriers
	B.5 Other products
	B.6 Waste imported for final treatment and disposal

4.6.2 Results

The material inputs and exports of EU-27 for the period 2000 to 2005 as derived from EUROSTAT, Questionnaire on Economy wide material flow accounts (EW MFA) from 04.02.2009, are shown in Annex 4 and summarised in Table 41 and Figure 48 to Figure 54 for the material categories:

- Biomass
- Metal ores
- Non-metalic minerals
- Fossil energy carriers and
- Other products.

From the data on domestic extraction (DE), imports and exports

- The DMI (direct material input = domestic extraction + imports)
- The DMC (domestic material consumption = domestic extraction + imports – exports) and
- the resource productivity (=GDP/DMI)

are calculated.

The DMI as a whole (see Figure 51) shows a slow growth with considerable fluctuations. Even stronger fluctuations can be seen e.g. with metal imports. While the average annual growth rate of this flow in the period 2000 to 2005 was 1.9 %, between the year 2002 and 2004 the metal imports grew by 12 % (see Figure 52).

Also the DMC shows fluctuations, which make any trend extrapolation difficult (see Figure 53).

Shown in Table 41 is also the average annual increase (decrease) of the different material flows for the period 2000 to 2005. It can be seen that for the period 2000 to 2005

DMI and DMC grew slower than GDP, resulting in growing resource productivity (see Figure 54). However, imports, especially metals, fossils and “other products” grow much faster than GDP.

Table 41: Material flows to/from EU (EU-27) in Million tonnes (Mt) (derived from EUROSTAT 2009c)

	2000	2001	2002	2003	2004	2005	Average increase in %/a for the period 2000 to 2005
Domestic Extraction in EU-27							
A.1 Biomass	1,616	1,570	1,588	1,469	1,656	1,591	-0.3
A.2 Metal ores (gross ores)	126	120	118	121	123	125	-0.2
A.3 Non metalic minerals	3,640	3,654	3,583	3,599	3,706	3,823	1.0
A.4 Fossil energy carriers	1,033	1,030	1,027	1,014	992	949	-1.7
Total domestic extraction	**6,415**	**6,373**	**6,316**	**6,202**	**6,478**	**6,488**	**0.2**
Imports to EU-27							
B.1 Biomass and biomass products	171	174	184	186	162	163	-1.0
B.2 Metal ores and concentrates, processed metals	205	199	198	216	231	226	1.9
B.3 Non metalic minerals primary and processed	104	110	109	114	110	109	1.0
B.4 Fossil energy carriers, primary and processed	924	949	957	1,028	1,053	1,088	3.3
B.5 Other products	25	26	26	29	31	31	4.9
Total Imports	**1,430**	**1,459**	**1,474**	**1,575**	**1,587**	**1,618**	**2.5**
Exports from EU-27							
D.1 Biomass and biomass products	125	115	123	131	109	113	-1.9
D.2 Metal ores and concentrates, processed metals	85	85	92	98	102	104	4.1
D.3 Non metalic minerals primary and processed	76	78	76	77	75	79	0.7
D.4 Fossil energy carriers, primary and processed	153	151	154	155	170	185	3.9
D.5 Other products	27	28	29	30	29	30	2.4
Total Exports	**466**	**458**	**475**	**490**	**486**	**512**	**1.9**
DMI (DE + Imports)							
Biomass and biomass products	1,787	1,744	1,772	1,655	1,818	1,754	-0.4
Metal ores and concentrates, processed metals	332	319	317	337	354	351	1.1
Non metalic minerals primary and processed	3,744	3,764	3,691	3,713	3,816	3,933	1.0
Fossil energy carriers, primary and processed	1,957	1,979	1,984	2,042	2,046	2,037	0.8
Other products	25	26	26	29	31	31	4.9
Total DMI	**7,844**	**7,833**	**7,790**	**7,777**	**8,065**	**8,106**	**0.7**
DMC (DE + Imports - Exports)							
Biomass and biomass products	1,662	1,629	1,649	1,524	1,709	1,640	-0.3
Metal ores and concentrates, processed metals	247	234	224	239	253	247	0.1
Non metalic minerals primary and processed	3,668	3,686	3,615	3,637	3,740	3,854	1.0
Fossil energy carriers, primary and processed	1,803	1,828	1,830	1,887	1,876	1,852	0.5
Other products	-2	-2	-3	-1	2	1	
Total DMC	**7,378**	**7,375**	**7,316**	**7,287**	**7,580**	**7,595**	**0.6**
GDP in Billion Euro, constant prices	9,202	9,384	9,502	9,629	9,867	10,061	1.8
Resource productivity GDP/DMI in	1.17	1.20	1.22	1.24	1.22	1.24	

	2000	2001	2002	2003	2004	2005	Average increase in %/a for the period 2000 to 2005
€/kg							

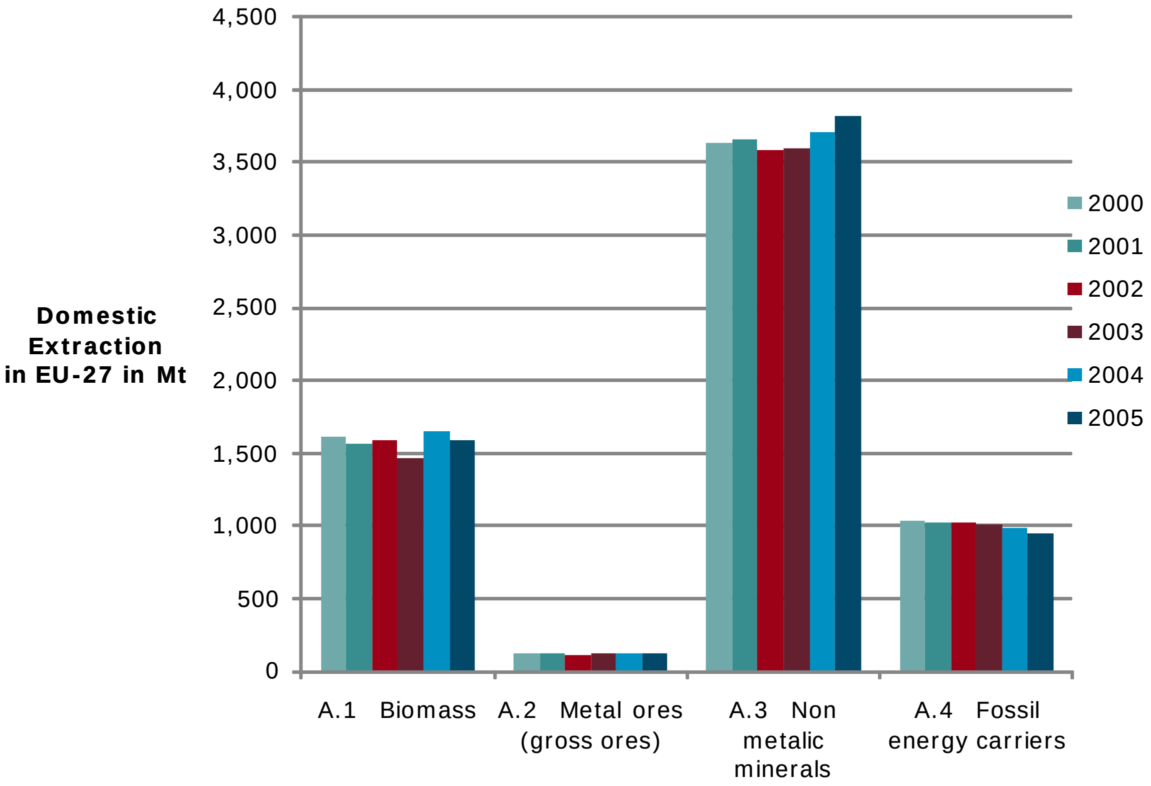


Figure 48: Domestic extraction in EU-27 in million tonnes (derived from EUROSTAT 2009c)

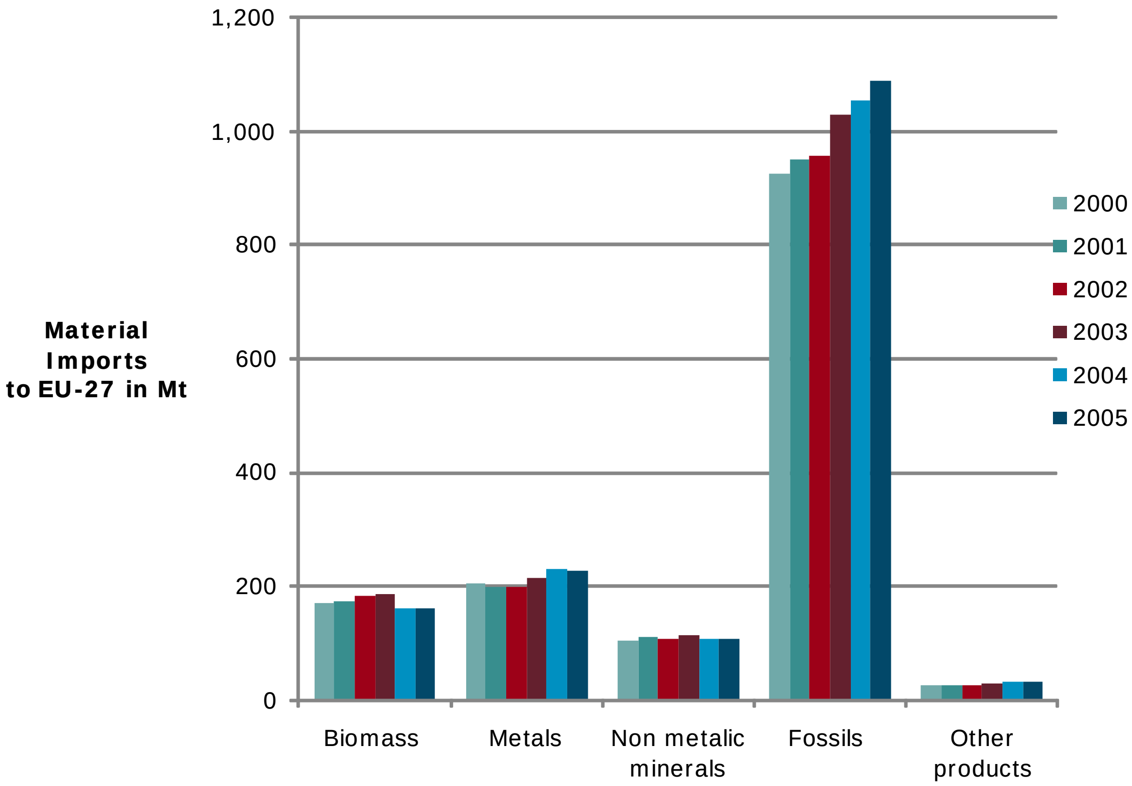


Figure 49: Material imports to EU-27 in million tonnes (derived from EUROSTAT 2009c)

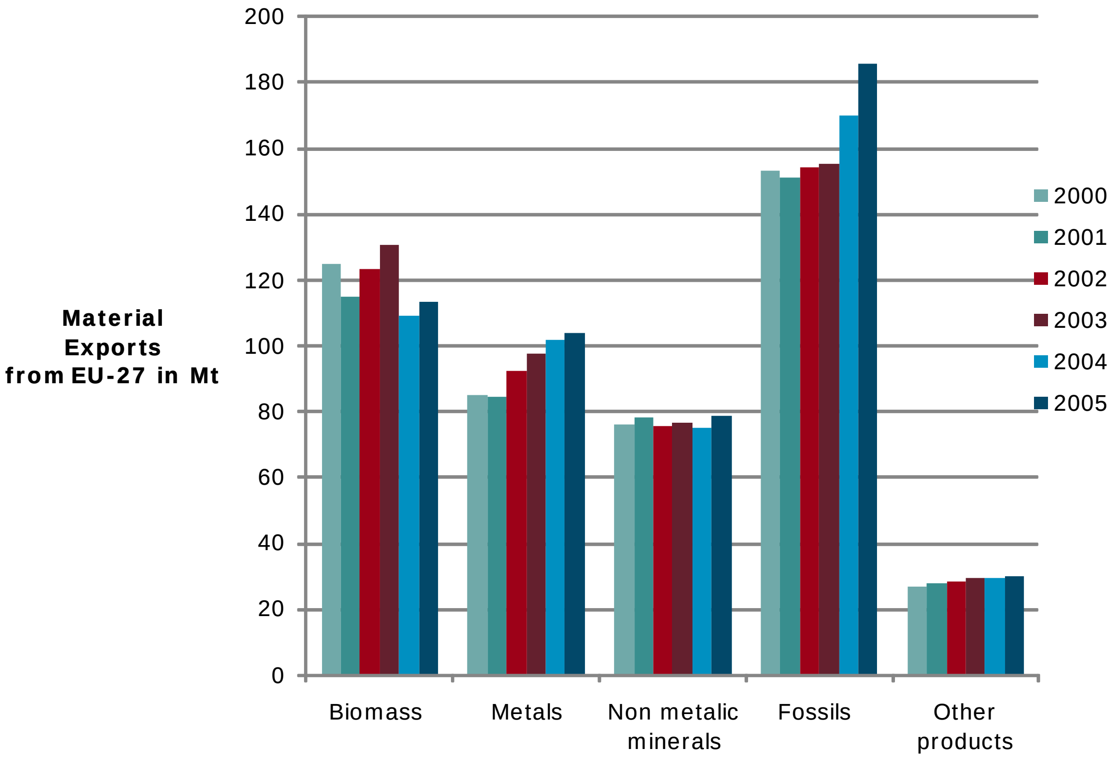


Figure 50: Material exports from EU-27 in million tonnes (derived from EUROSTAT 2009c)

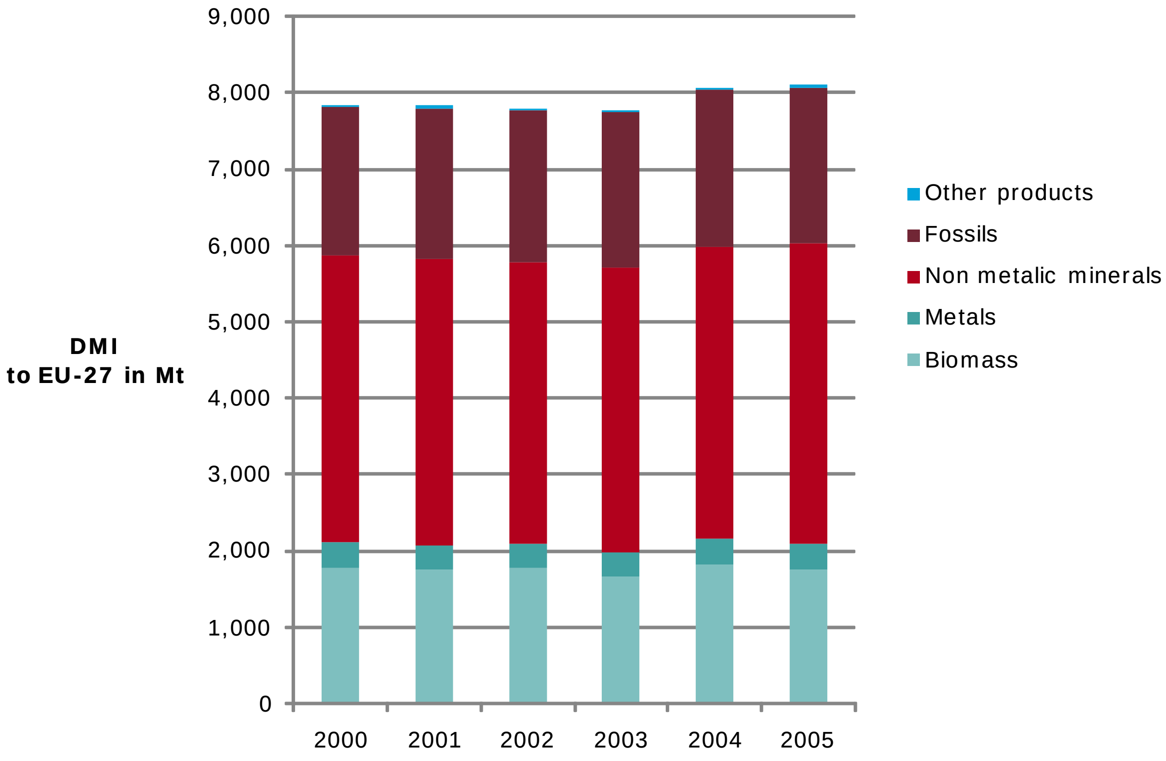


Figure 51: DMI (direct material input) to EU-27 in million tonnes (derived from EUROSTAT 2009c)

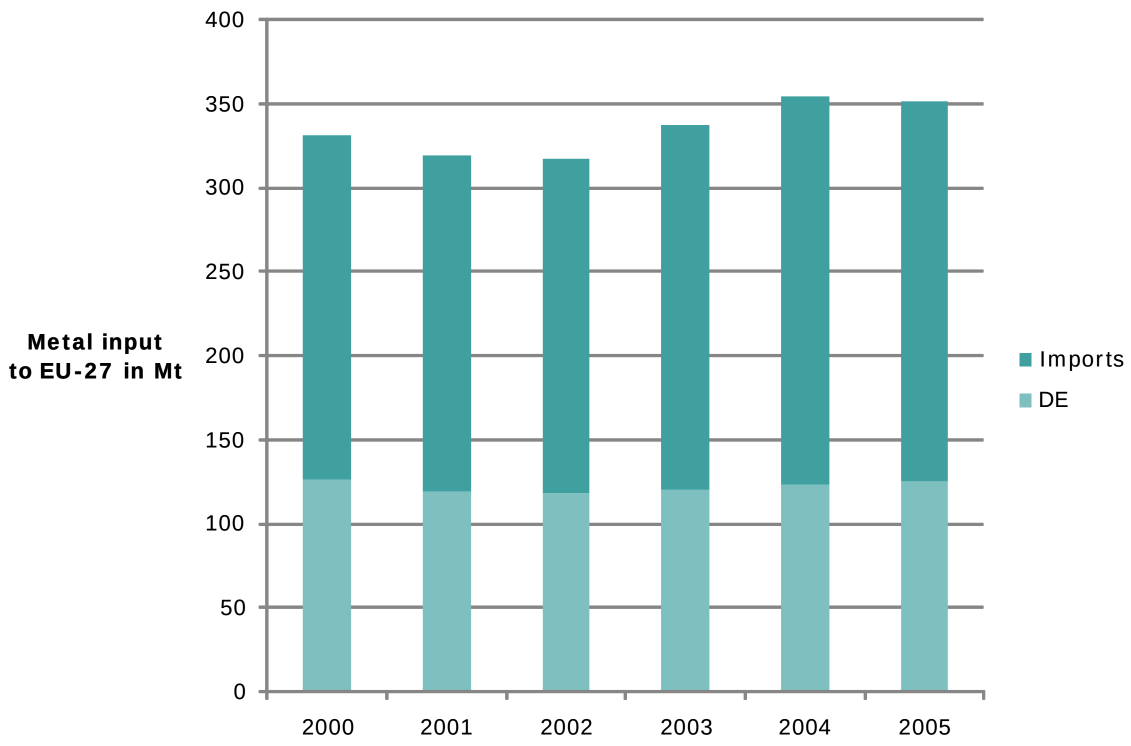


Figure 52: Metal input to EU-27 in million tonnes (DE = domestic extraction) (derived from EUROSTAT 2009c)

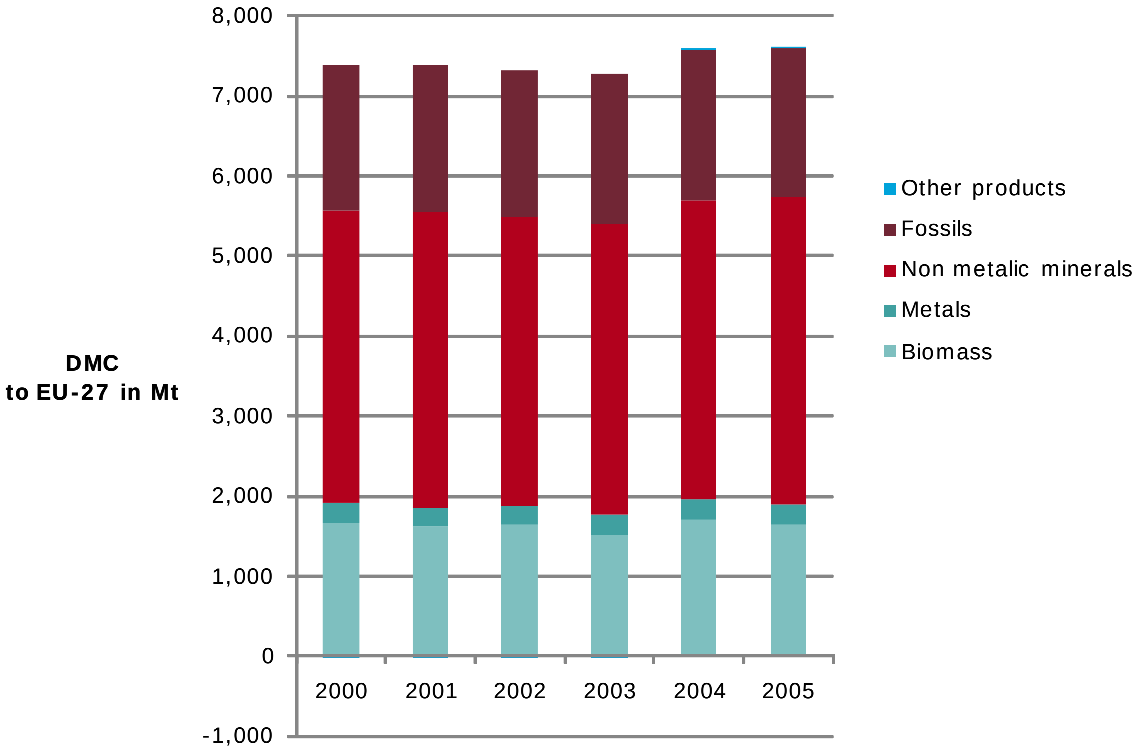


Figure 53: DMC (domestic material consumption) of EU-27 in million tonnes (derived from EUROSTAT 2009c)

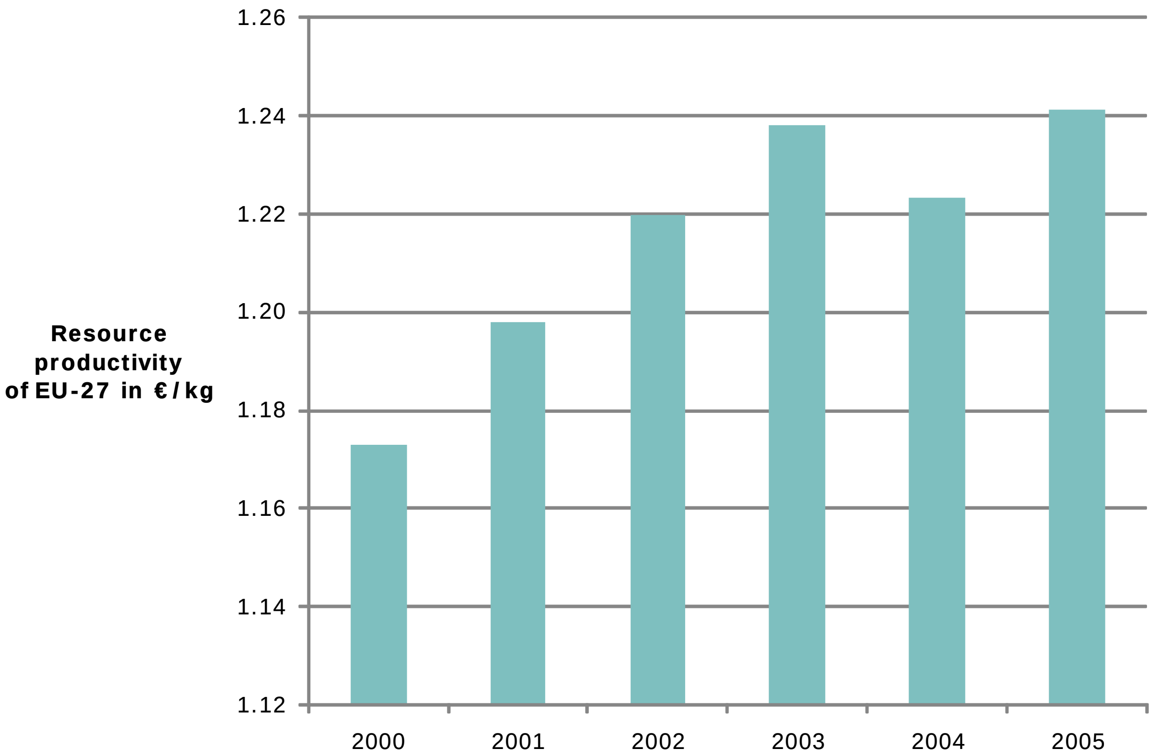


Figure 54: Resource productivity as GDP/DMI in €/kg for EU-27 ((derived from EUROSTAT 2009c)

4.7 Comparison of waste data & material flow data

4.7.1 Detailed approach

In this chapter the collected data on waste generation at high aggregation level will be compared to those of the resource extraction / use and production of goods in order to explain the main relations between material flows going into the EU-27 economy and the resulting waste generation coming out of the economic system.

In the context of this reviewing study following comparisons/interpretations are made

1. Total material flow data with total waste data
2. Some results from a recent FP6 project called Forwast

4.7.2 Results

4.7.2.1 Comparison of total material flow data with total waste data

The best indicator that has the closest causal relation with waste generation is considered to be the Domestic Material Consumption (DMC) which is built up from Domestic Extraction (DE) plus Import minus Export. Figure 53 shows how much materials from four main streams enter the EU economy.

On average during the years 2000 till 2005 a total of 7,903 Mt materials (sum of imported materials and domestic extraction in the EU27) entered the economy. Approximately 481 Mt of materials was exported out of the European economy. Resulting in a DMC of the EU27 of 7,419 Mt.

A small amount (0.379 Mt) of waste entered the economy. The total waste generation (Figure 19) in the years 2004 and 2006 is approx. 2,940 Mt. The average amount of waste treated in the EU27 in the years 2004 and 2006 amounts to 3,788 Mt (Figure 23). It is clear that there is a big gap between both figures that is probably caused by double counting of secondary waste (waste that is produced by the waste treatment sector). An overview of this is given in following Figure 55.

The EUROSTAT Questionnaire on Economy wide material flow accounts (EW MFA) from 04.02.2009 does not differentiate between products or wastes being imported or exported. Wastes imported for recycling are considered a raw material. For this reason table 4 cannot confirm or refute the statement that waste shipments are a net material leakage or not. Data on imported wastes are available and assessed at an average of 3.792 kt between 2000-2005. Waste recycled within the EU is assessed at 1.124 Mt. Glass is assessed to be recycled outside the EU for 1%, plastic for 55%, metal for 12% and paper for 7%, calculated from paragraph 4.5.2.4. No data for other waste streams are available. However only if less than 0,34% of the total amount of recycled waste would be recycled outside the EU there would not be a material leakage. The figures, even incomplete, show a considerable risk of material leakage through waste shipment. This is however by large compensated by the much higher imports of materials as products or as raw materials compared to the exports as mainly products. Material shortages through waste shipments will not occur at a general level, but may be problematic for specific rare material types.

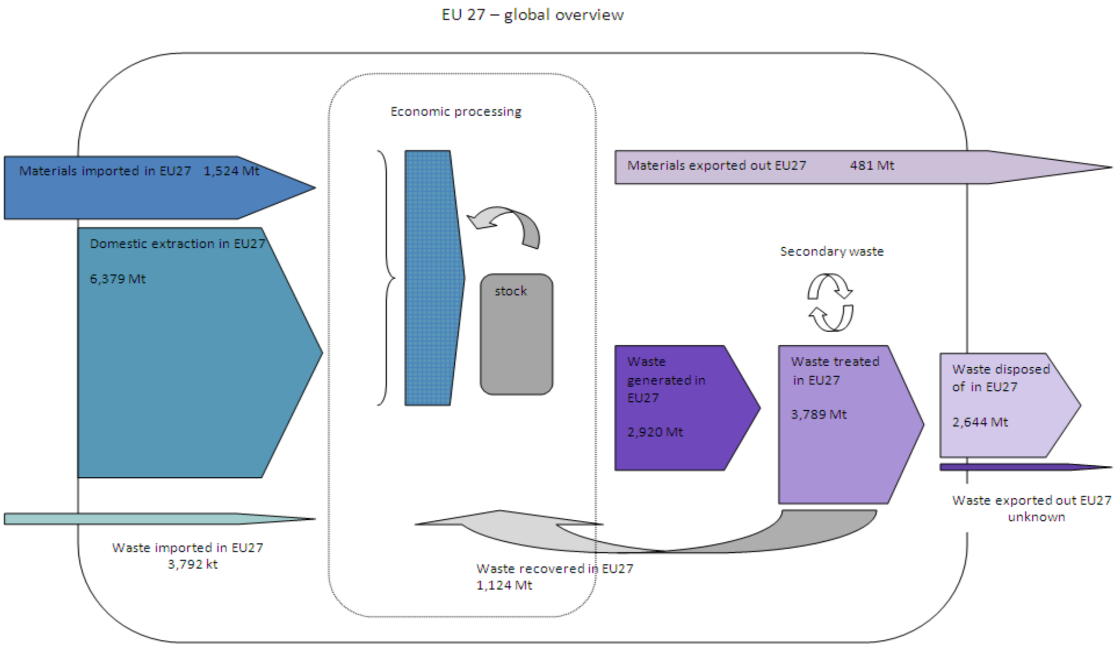


Figure 55: Overview of the average material input (2000 – 2005) and waste output (2004 & 2006) of the EU27

These figures show that from the entering material streams approximately 40% leaves the economy as waste in the same year. From this waste stream again 40% flows back to the economy to be recovered as a material or a fuel. There are three main reasons that can explain these differences:

1. A fraction of the material is used as a fuel (fossil fuels, biomass) that are mainly used for heating, transport, electricity and industrial processes leading to emissions to air and only some limited amount of ashes. These emissions are not included as they are not included in the waste statistics that are used. From oil only approx. 4 % is used for the production of plastics that will get visible in the waste statistics.
2. A fraction of the biomass that enters the economy is used as food or feed. These fractions that we consume as humans (or animals) for distracting energy are evidently much condensed when reaching the waste phase (as sewage waste of manure).
3. A third fraction stays within the economy as a stock. Due to demographic reasons and economic trends many minerals and metals are still building up as stocks in all kind of growing numbers of long living products like cars, furniture, buildings, infrastructure. For long living products there is a delay for material streams entering and leaving the economy. Short living products like packaging and food/feed usually enter and leave the economy the same year.

To understand the existing waste generation pathways and potential for improvement one needs to identify and assess many specific pathways through the economy taking into account the life time of products, the resulting waste and the potential for improvement. As already reported in chapter 4.2 the economic system is very complex with many pathways for materials going through the economy through numerous processes and products. This makes a correct assessment very difficult from a top-down approach or very elaborate to track all these pathways individually from a bottom up approach.

Furthermore the statistics on waste use different categories that are not directly related to material flows entering the economy. The European Waste List categorises waste according to its sector of origin (e.g. mining waste), its material of origin (e.g. mineral oil waste) or its use (e.g. construction waste). This mix of criteria for categorizing waste, together with the complex path most materials follow through the economy, makes it difficult to determine the identity between material flows and the corresponding waste streams. However, in what follows we tried to link the different types of waste that are generated to the different types of input material. This was done using a pragmatic approach and common sense. Doing so approximately 80% of the generated waste and 90% of the treated waste can be related directly to entering material flows. The most important fractions that are not taken into account using this method are chemical wastes. For these waste-streams it is not very clear from which type of material they originate, so they were not included in the evaluation.

Biomass

For biomass the DMC of the EU 27 is 1,636 Mt, representing 22% of the total DMC of the EU27. Only 25% of this amount shows up in the waste treatment statistics. This can be explained that from the generated waste from agriculture for instance there is a practice of direct reuse within the sector. So this fraction does not appear in the waste treatment statistics. Additional explanations can be that fractions like wood or textiles are still building up stocks. And also that for instance home composting is not visible in the waste statistics.

From the treated bio-waste 1/3 is sent back to the economy for material recovery. The remaining part is disposed.

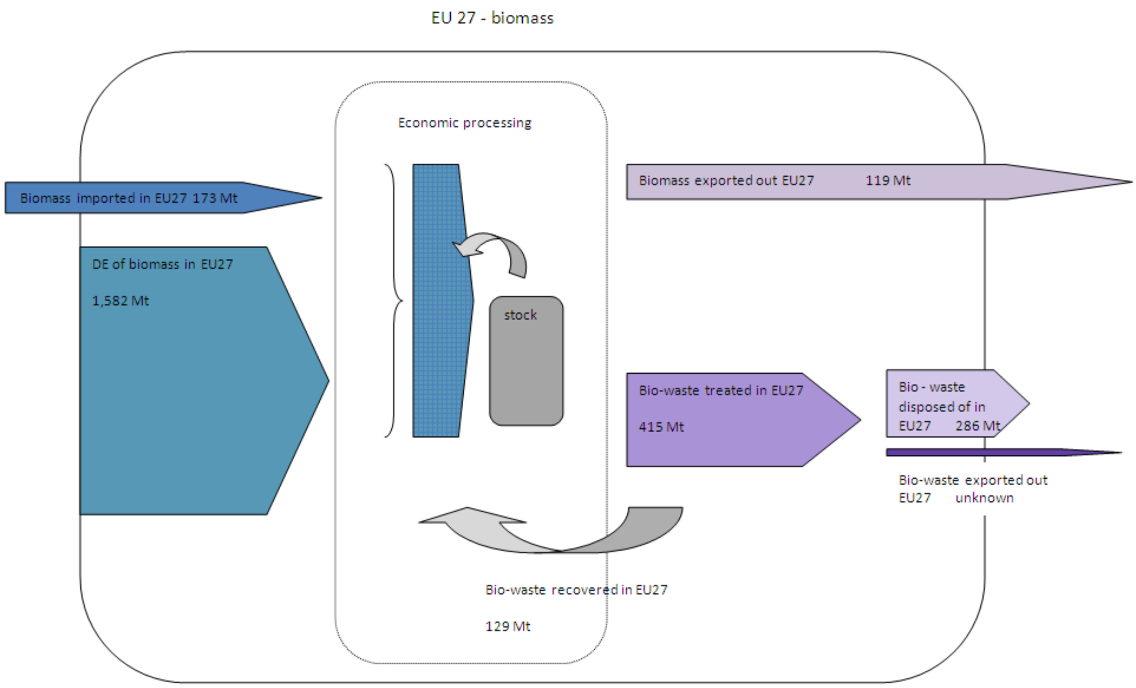


Figure 56: Overview of the average biomass input (2000 – 2005) and waste output (2004 & 2006) of the EU27

Based on the waste treatment statistics, bio-waste consists mainly out of the assumed fraction that is present in the waste category 'household and similar waste' (> 60%). The remaining fraction consists mainly out of the categories 'animal and food waste' (11%), 'paper and cardboard' (9%) and 'wood waste' (7%). Smaller fractions are 'animal faeces', 'textile waste' and 'health care waste'. Almost 95% of the 'household and similar waste' is being disposed of. This represents almost 45% of the treated bio-waste. The majority of the recovered bio-waste consists out of the separate collected fractions (such as 'animal and food waste', 'paper and cardboard', 'wood waste', 'textile waste' and 'animal faeces' which are sent entirely to recovery.

Metallic

The DMC for the metallic fraction is 241 Mt. This fraction represents only 3% of the total DMC of the EU27. Approximately 1/3 of the used metallic fraction is treated as waste. This total amount is sent back to the economy. This is due to the fact that in our calculations we only took the waste category 'metallic waste' from the waste treatment statistics into account. This is probably a separate collected fraction. Some other (mixed) waste fractions, such as sorting waste, household waste etc. will also contain metals, that are probably not (all) recovered.

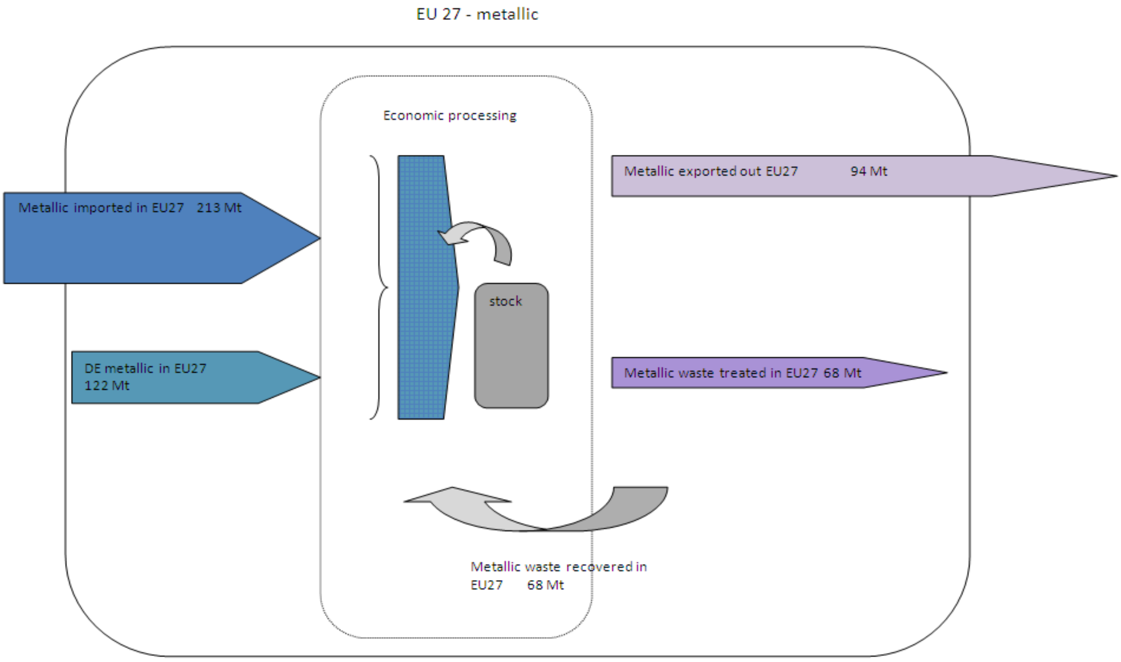
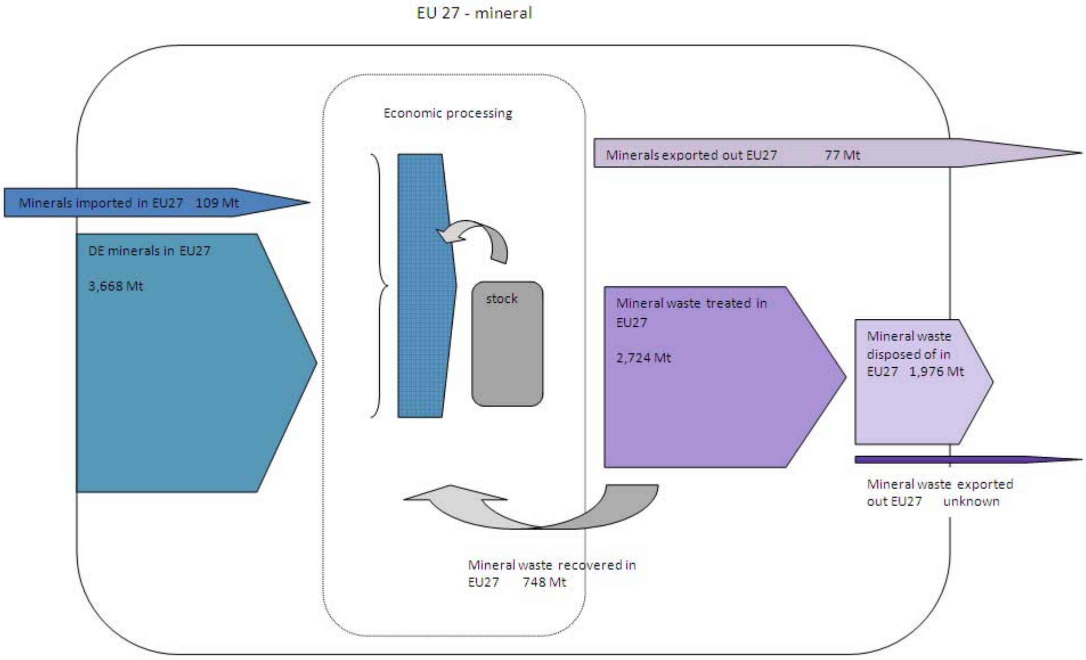


Figure 57: Overview of the average metallic input (2000 – 2005) and related waste output (2004 & 2006) of the EU27

According to the waste generation statistics the majority of metallic waste is produced (as could be expected) by the metallurgic sectors 'manufacture of basic metals and fabricated metal products' and 'manufacture of machinery and equipment'. A smaller part is present in some mixed wastes such as ELV's, WEEE and packaging waste.

In the waste treatment statistics only a part of the generated metallic waste is shown, as mentioned before. This is probably due to the fact of some double counting in the waste treatments statistics of secondary waste. A part of the treated metallic waste is coming from ELV's, WEEE and packaging waste. For ELV's and WEEE there are no exact



figures in the statistics concerning the recovered metals. For packaging waste approximately 3.2 Mt is recycled in the EU27.

Based on the available data it is impossible to determine which part of the metallic fraction that is not shown in the waste treatment statistics is building up as stock, and which part is present in the mixed fractions that are not covered in this evaluation.

Minerals

For minerals the DMC is 3,700 Mt. This fraction represents almost 50% of the total DMC of the EU27. More than 70% of this material stream is treated as waste in the same year. Almost 28% of this treated waste stream is sent back to the economy. The remaining 72 % is being disposed of.

Figure 58: Overview of the average mineral input (2000 – 2005) and related waste output (2004 & 2006) of the EU27

According to the waste treatment statistics, this waste fraction of minerals consists mainly (99.5%) out of the waste category 'mineral waste'. The remaining part consists of 'glass waste'. The majority of the 'mineral waste' (75%) is being disposed of or deposited onto or into land. The remaining part is sent along with the entire category 'glass waste' back to the economy for recovery.

When we look at the waste generation statistics we can see that the waste category 'mineral waste' consists for approximately 50% out of waste produced by the mining and quarrying sector and 50% is produced by the building sector. For this last sector there are more detailed data available regarding the treatment of this fraction (C&D waste). During the years 1995 to 2005 50% on average of the construction and demolition waste was recycled in the EU27. This indicates that the total amount of waste produced by the mining and quarrying sector is being disposed of.

From the available statistics (in chapter 4) it is not directly visible whether the mineral waste that is produced by the mining and quarrying sector is included in the Domestic Extraction figures. If this amount is indeed included, this would mean that 20% of the minerals that enter the EU27 economy is directly discarded as waste, and should be considered as a hidden stream.

Fossil fuels

The DMC for fossil fuels of the EU27 is 1,845. This fraction represents the remaining 25% of the total DMC. This fraction is mainly used as a fuel (as also mentioned above) and due to this a large fraction will not show up in the waste statistics. As also mentioned previously, approximately 4% of the fossil fuels that enter the economy is used for the production of plastics. Another fraction of fossil fuels that are not directly burned, are those that are used to produce lubricants. These two fractions explain the small percentage of only 5 % showing up in the waste statistics coming from fossil fuels. From that treated waste stream 27% is sent back to the economy for recovery (both as a material as for energy recovery). The remaining 73% is disposed of. This fraction is represented by the fraction of plastics that is assumed to be present in mixed wastes (such as household waste). The majority of these mixed fractions is disposed of or deposited on or into land.

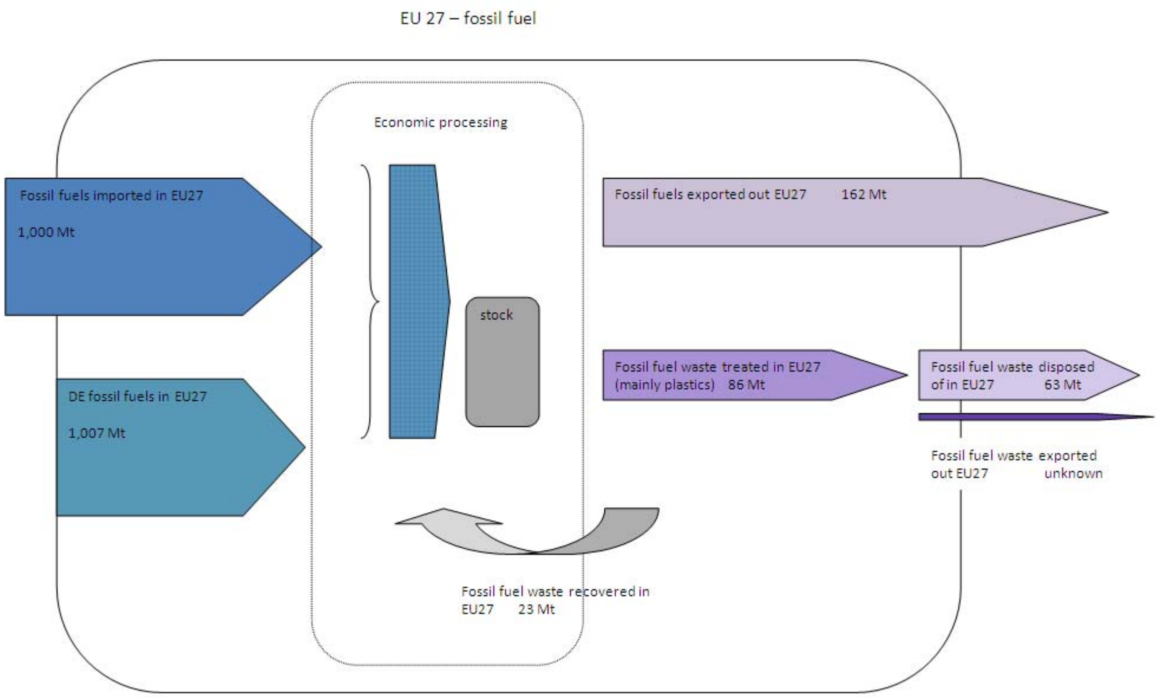


Figure 40: Overview of the average fossil fuel input (2000 – 2005) and related waste output (2004 & 2006) of the EU27

4.7.2.2 Some results from the recent FP6 project called FORWAST

There has been a recent and elaborate effort in the FP6 program through the FORWAST project. Based on 151 man-months partners developed a model for the physical flows and stocks for the EU-27, including waste and scenario development. This project has published the methodological approach and first results, but not all underlying details on data and correct communication are public. The model contains assumptions on composition and lifetimes of different products in order to construct a full societal picture on stocks. Also the available historical time series on physical flows needed to be extrapolated for the period 1903-1970, assuming exponential relation.

A concluding workshop was held at the end of 2009. A model has been constructed based on data from 20 EU countries which represent 38 % of EU-27 GDP. The expansion to EU-27 has been performed on GDP basis. More information can be found on http://forwast.brgm.fr

Main conclusions on waste generation from this research project were:

- FORWAST model leads to significant higher waste generation than existing statistics
- Waste generation in 2035 forecasted to increase 55 % - 88 % compared to 2003
- Overall waste generation can be reduced by waste prevention and not by treatment and recycling

The stock calculated in this model for 2003 based on FORWAST in relation to resource extraction in 2003 based on statistics gave the following results:

Table 42: Accumulated stocks in EU27 in 2003

Accumulated stocks in EU27 in 2003

Stock category		Quantity, dry weight (Million t)
Stocks in the economy		
Construction materials (minerals)		150,077
Textile		105
Wood		3,280
Paper products		210
Plastic		139
Glass		558
Metal products		3,214
Total		157,583
Stocks not in use		
Stock in landfill	Landfill of waste: Food	5,922
	Landfill of waste: Paper	1,317
	Landfill of waste: Plastic	1,247
	Landfill of waste: Metals	2,249
	Landfill of waste: Glass/inert	186,695
	Landfill of waste: Mine waste	3,954
	Landfill of waste: Textiles	223
	Landfill of waste: Wood	2,568
	Landfill of waste: Oil/Hazardous waste	8,665
	Landfill of waste: Slag/ash	32,550
Total		245,388

For comparison:

Ressource extraction in 2003	Quantity, dry weight (Million t)
Agriculture	1,133
Forestry	317
Coal	761
Oil and gas	355
Metal ores	88
Minerals	3,610
Total	6,263

Conclusions from these tables are:

- There is more stock in landfill than in existing products in use for most materials except for metals.
- The minerals in stock are by far the most important volume in tons both in products in use (95 %) and landfill (75 %).
- Biomass evidently is an important yearly material input stream but hardly contributes to stock building (only some wood and paper).

4.8 Key environmental impacts / LCA

4.8.1 Detailed approach

The objective of this paragraph is to map out the key environmental impacts from the material flows described in paragraph 4.6. These insights should contribute to identifying the most relevant potential areas for reducing environmental impacts from waste prevention measures.

The most recent insights are summarized from mainly top-down approaches trying to describe the key impacts associated with the main material flows at macro level entering the EU economy.

Additionally information on available public LCA data in the ELCD database for the materials constituting the material flows are presented on a per kg basis to help quantifying the benefits from waste prevention in Task 3. The ELCD database is still under development, coordinated by JRC-Ispra.

It is not the scope of this chapter to develop a full scale life cycle analysis for each of the material/waste streams (metals, paper, glass, plastics, bio-waste, minerals; industrial, agricultural & forestry, construction & demolition, household & similar as well as secondary waste; hazardous waste). Focus is laid on delivering the key environmental aspects on which a full scale LCA can be built. These results lead further on in chapter 4.8.2 to a quantified maximum potential impact reduction for waste prevention.

4.8.2 Key environmental impacts from the material flows at macro level

Any material flow entering the economy will once leave the economy as waste. One of the forms of prevention within the scope of waste prevention is using simply less materials while providing the same function. This will lead to less materials to be produced and therefore less environmental impacts from production and waste management. Part of this environmental gain will get lost through the rebound effect if less material used in products also leads to cheaper products allowing for additional money to be spent on other products.

The EU and world economy is a very complex system containing hundreds of thousands different products that use materials and other resources during production, use and disposal/recycling. There exist mainly two approaches to identify **priority products** from an environmental perspective:

1. Top-down approaches, most often based on Environmentally Extended Input-Output Analysis (EE-IOA) which have the advantage of being based on consistent and complete economic accounting systems to which environmental sector emissions and resource uses are added.
2. Bottom-up approaches based on LCA that try to provide an overview based on LCA's of many different products. LCA has the benefit to be more specific and provide more detail per product, but not all products in the world have been subject to (public) LCA and simply adding up LCA results will lead to double counting especially for complex products.

For **material flows** also two approaches to identify the priorities exist:

1. Material flow accounting in its basic form, using the weight of the flows as a proxy for relevance. Quite often the DMC (Domestic Material Consumption = domestic extraction + import – export) for materials is used as a proxy also for waste generation as ultimately at the end of all the material/product cycles the materials will turn into waste, after temporary stock building.
2. A second approach adds environmental relevance to these MFA by providing mainly environmental data on production and waste management. It is very complicated to also add correctly for instance the average energy use and consequent impacts of the

products that use these materials, as this is determined by the specific use in a variety of products. Example: polystyrene can be used as a packaging material with a short lifetime before entering the waste/recycling phase. Polystyrene can also be used as a long lifetime insulation material in buildings saving a lot of energy, more than ever used for producing it. In this second approach the environmental consequences of burning fossil fuels because of using steel in a car are not attributed to the steel but to the product car, needing fossil fuels.

Regarding the MFA the trends and main contributors have been described in paragraph 4.6. The relation between MFA and waste statistics has been described in paragraph 4.7. In this paragraph the focus is on the environmental impacts associated to the main material streams described in paragraph 4.7.

The most recent and authoritative review on assessing the environmental impacts of consumption and production has been published by the UNEP resource panel in May 2010 (Hertwich, 2010). The goal was to identify priorities among industry sectors, consumption categories and materials perspective. These perspectives are not completely independent as certain impacts (like production emissions) are included in all three perspectives. The assessment is based on different studies (at country, country groups or world level), but no primary research was done.

A good overview on the key environmental impacts comes from an EMC model (Environmentally weighted Material Consumption) which is based on DMC figures for EU 27 + Turkey for the year 2000 and available environmental information from the ETH LCA commercial database for ten material groups and in 13 impact categories (CML 2002 impact categories).

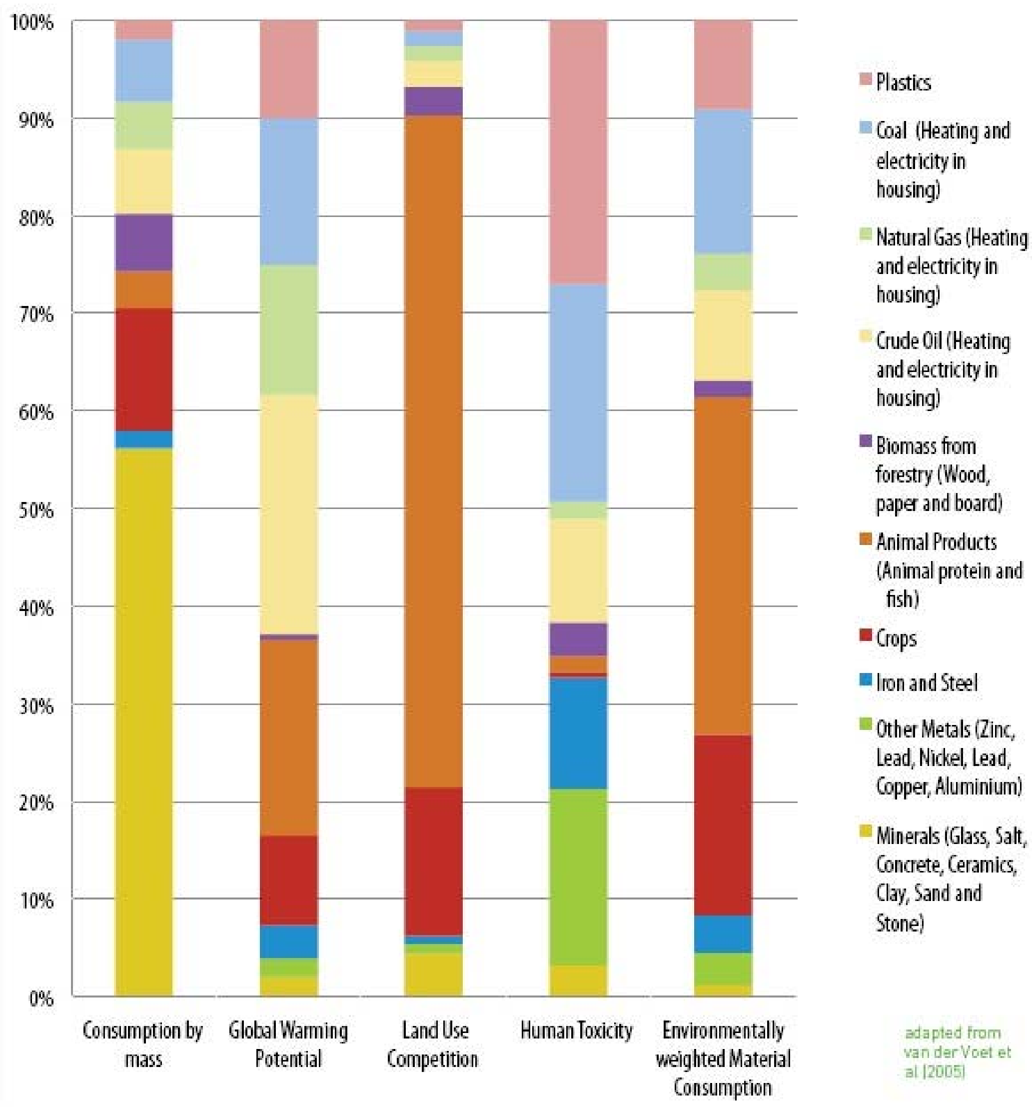


Figure 59: Relative contribution of groups of finished materials to total environmental problems (total of the 10 material groups set at 100 %), EU-27 + Turkey, 2000. (Hertwich, 2010)

Lessons from Figure 59:

The first column shows, in line with paragraph 4.7, that when looking to DMC (apparent consumption by mass) for the ten identified material groups, minerals (56 %) are the highest contributor, followed by crops (13 %), coal (6 %), crude oil (6 %), biomass (5 %) etc. Focusing on materials because of their weight yearly used on macro level, would clearly prioritize the minerals.

The second column shows that considering the impact of global warming potential only, the minerals on the contrary have a much smaller relative contribution and crude oil, animal products, coal, natural gas, plastics and crops turn out to be the most contributing material groups. When selecting priority materials weight can be a good proxy for waste generation and thus focus on waste prevention, but regarding global warming the priorities are very different.

For other impacts again different priorities result: considering land use competition animal products and crops are dominating.

Focusing on (the less well developed impact category) human toxicity: plastics, coal, other metals, iron and steel, and crude oil determine most of the impacts among the ten material groups.

There exist different environmental problems and impact categories. There still is no consensus on the relative weight/importance of different impact categories, but if equal weight is given to each impact category (from CML 2002) the result is given in the last column: animal products, crops, coal, plastic, crude oil are the main contributors to environmental impacts.

More details on contributing materials can be found in the figures below.

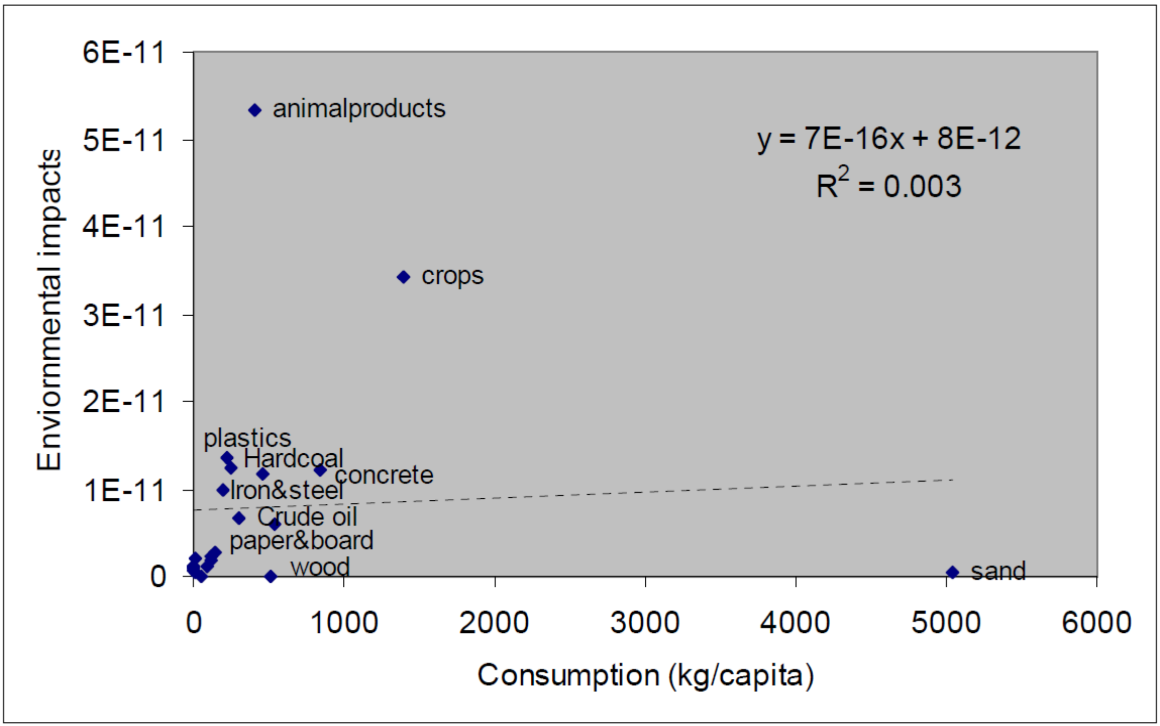


Figure 60: Environmental impacts defined as EMC as a function from yearly consumption, for materials including crops, animal products and sand (Van der Voet, 2005).

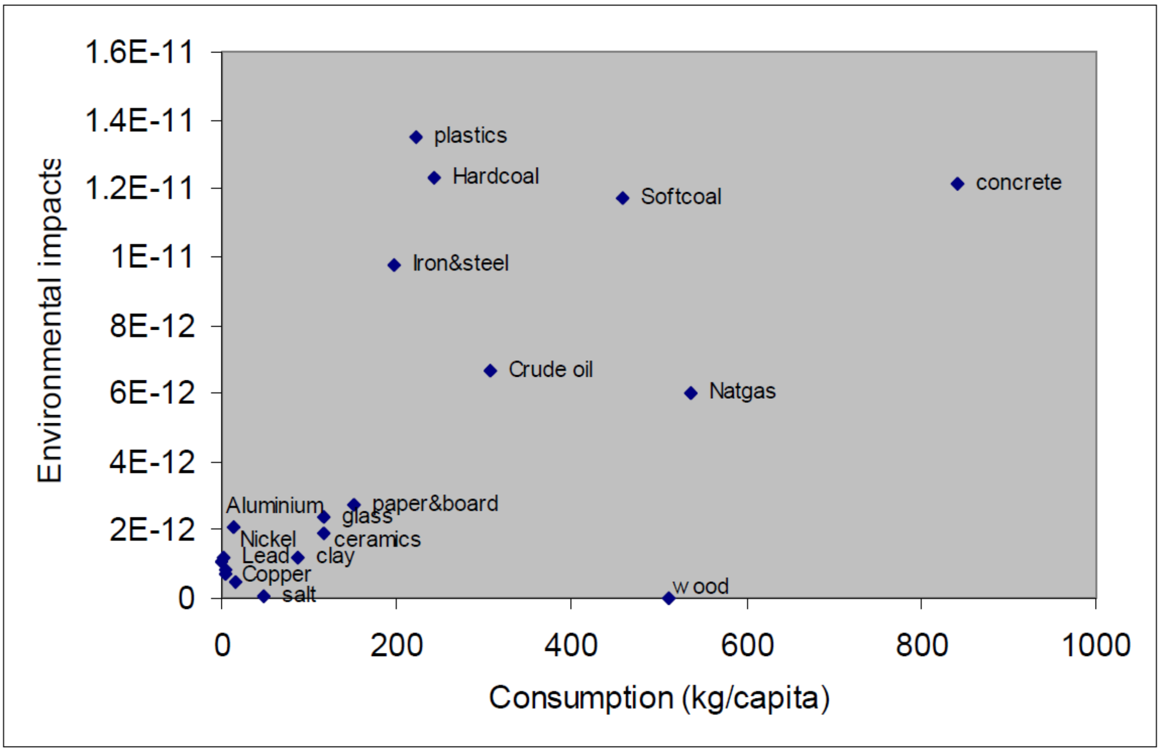


Figure 61: Environmental impacts defined as EMC as a function from yearly consumption, excluding crops, animal products and sand (Van der Voet, 2005)

According to the UNEP resource panel report (Hertwich, 2010), the main materials to focus on are crops and animal products due to their (energy, pesticide) intensive agriculture and high demand on land use, evidently fossil fuels for application in transport, heating and electricity. Furthermore steel, iron, plastics, aluminium and cement as abiotic materials used in buildings, transport and any kind of commodity.

The EU EIPRO study (Tukker, 2000) provides more detail not on materials but on product groups to be targeted when wanting to reduce the environmental impacts. Of course these product groups contribute to environmental impacts not only by using materials and producing waste but also by using fossil fuels. In the EU EIPRO study an environmentally extended Input-Output model was constructed simulating the European EU-25 production situation by using the detailed industrial structure from the USA CEDA database, serving final private and public consumption. Per impact category rankings were made on the top 35 contributing products or product groups. Life cycle emissions are projected on the final consumption products. For global warming the product groups of driving passenger car and motor vehicles, eating and drinking places, meat packing plants, heating, poultry slaughtering, new residential units, sausages and prepared meat, milk, cheese, washing with household laundry equipment already cover over 50% of the total life cycle emissions. These product groups are also very important in the other impact categories like ozone layer depletion, human toxicity, ecotoxicity, acidification, photochemical oxidation, eutrophication, abiotic depletion.

4.8.3 LCA data from public EU ELCD database for materials per kg constituting the main material flows.

The focus on waste prevention in this study is on reducing the waste to be created, or even by reducing the amounts of materials in use to be reduced, as all materials eventually become waste. The focus on improvements in recycling rates and environmental gains associated with that are the subject of a separate Framework study.

In order to quantify the environmental benefits of ideas for using less of less hazardous materials public LCA data from the ELCD database (still in development) at JRC Ispra can be useful. Commercial LCA databases today are more complete in terms of number of data records on materials and processes but the use of public data is a fair principle for public policy. Another argument to use public LCA databases is that license conditions from commercial databases do not allow for publishing environmental basic data from materials at the level of data records.

The import of ELCD data through an automated conversion tool into the LCA commercial software in order to calculate the environmental impacts at aggregated level is an issue still to be resolved in practice.

In the ELCD databases (http://lct.jrc.ec.europa.eu/assessment/data) only a limited number of materials constituting the material flows are available yet. For the available materials emissions are reported in the database. Below production emissions CO_2 and CH_4 as important contributors to global warming are presented for the available materials or products relevant for the material flows considered in this project. As can be seen high scoring materials on a per kg basis are zinc, aluminium, lead, copper, steel and cement.

ELCD data on CO_2 and CH_4 production emissions are added in Annex 6.

5 Task 3: Waste prevention potential and impacts

5.1 Scope

The objectives of this chapter are:

- To establish the waste prevention potential from a number of perspectives; the estimation focuses on seven material flows, and on the prevention of waste generated at the production phase and end-of-life of these materials
- To estimate the potential environmental benefits of waste prevention using an LCA approach; the potential benefits of preventing one tonne of waste (for each of the seven materials selected), and the total potential benefits
- To evaluate trade offs between waste prevention and environmental impacts

5.2 Establishing the waste prevention potential from a number of perspectives

5.2.1 General approach and limitations

Waste prevention can occur at every stage of the life cycle of a material or product. Waste prevention measures and potential, as well as the associated environmental impacts, depend on the activity generating the waste (e.g. production or consumption).

The approach adopted in this report is a **material** approach. Such an approach aims at giving a general overview of the waste prevention potential in Europe, based on the major material flows in the economy; however, it is not a product by product analysis, and as such does not establish the waste prevention potential from the perspective of products or product categories. Likewise, the environmental assessment below takes into account the impact of material but does not consider the impact of products.

The material streams covered are:

- Mineral
- Wood
- Bio-waste
- Plastics
- Paper and cardboard
- Glass
- Metals

5.2.2 Linking waste data to the life cycle of the material

As mentioned previously, waste prevention can occur at every stage of the life cycle of the material during which waste is generated. EUROSTAT data allows the identification of the sectors of activity generating the waste. These sectors of activity can be linked to different stages of the life cycle of the materials (e.g. manufacturing of materials or good to the production phase).

Available waste data do not allow the distinction of the distribution and use phases; these phases of the life cycle will therefore not be addressed here. The electricity, gas and water supply, the construction sector, other services and households are considered to be the end-users of the materials, and waste generated by these activities is considered to be end-of-life material.

Secondary waste is excluded from the scope of this analysis, and therefore the following sectors of activity:

- Recycling (NACE code DN37)
- Wholesale of waste and scrap (NACE code G5157)
- Sewage and refuse disposal, sanitation and similar activities (NACE code O90)

5.2.3 Summary of waste data

The following table presents the total waste generated by all activities (excluding waste management activities), for each category of waste, and how these waste are related to the material streams selected for this analysis.

Table 43: Attribution of waste streams to selected material flows, data from EUROSTAT (2006)

EWCStat-Name	EWCStat-#	Total generated (million tonnes)	Material flow
Spent solvents	EWC_011	2.6	N/A
Acid, alkaline or saline wastes	EWC_012	7.7	N/A
Used oils	EWC_013	5.8	N/A
Spent chemical catalysts	EWC_014	0.2	N/A
Chemical preparation wastes	EWC_02	6.0	N/A
Chemical deposits and residues	EWC_031	19.3	N/A
Industrial effluent sludges	EWC_032	8.8	N/A
Health care and biological wastes	EWC_05	2.4	N/A
Metallic wastes	**EWC_06**	**60.9**	**Metals**
Glass wastes	**EWC_071**	**14.1**	**Glass**
Paper and cardboard wastes	**EWC_072**	**60.4**	**Paper**
Rubber wastes	EWC_073	3.1	N/A
Plastic wastes	**EWC_074**	**14.3**	**Plastics**
Wood wastes	**EWC_075**	**81.4**	**Wood**
Textile wastes	EWC_076	3.6	N/A
Waste containing PCB	EWC_077	0.1	N/A
Discarded equipment (excluding vehicles & batteries)	EWC_080_NOT_081_0841	2.5	N/A
Discarded vehicles	EWC_081	9.0	N/A
Batteries and accumulators wastes	EWC_0841	1.2	N/A
Animal waste of food preparation and products	**EWC_0911**	**12.7**	**Bio-waste**
Animal faeces, urine and manure	EWC_093	125.1	N/A

Other animal and vegetal wastes	**EWC_09_NOT_0911_093**	**94.2**	**Bio-waste**
Household and similar wastes	**EWC_101**	**198.0**	**Bio-waste, paper, etc.***
Mixed and undifferentiated materials	EWC_102	39.9	N/A
Sorting residues	EWC_103	5.3	N/A
Dredging spoils	EWC_113	46.1	N/A
Common sludges (excluding dredging spoils)	EWC_11_NOT_113	8.3	N/A
Mineral wastes (excluding combustion wastes, contaminated soils &polluted dredging spoils)	**EWC_121_TO_125_NOT_124**	**1810.8**	**Mineral**
Combustion wastes	EWC_124	143.8	N/A
Contaminated soils and polluted dredging spoils	EWC_126	8.4	N/A
Solidified, stabilised or vitrified wastes	EWC_13	2.1	N/A
Total Waste		**2797.9**	
Total selected		**2346.7**	

Waste streams that cannot be linked to one of the main material streams selected above were excluded from this analysis.

Overall, this selection covers 2 347 Mtonnes of waste, which represents over 80 % of all waste generated in the EU (excluding secondary waste from waste management activities).

*The category "household waste" is composed of mixed materials. Using an estimate of the average composition of household waste, this waste stream can also be related to the selected materials (see 5.2.3.3).

Waste is generated at each stage of the life cycle of the material. EUROSTAT allows the identification of the sectors of activity generating the waste, which in turn can be associated to either the extraction, production, or end-of-life of the material.

5.2.3.1 Waste generated during the extraction process

NACE codes A, B and C correspond to extractive industries, namely "Agriculture, hunting and forestry", "Fishing", and "Mining and Quarrying".

The following table presents the waste generated by these extractive industries, for each category of waste selected (Source: EUROSTAT).

Table 44: Waste generated during the extraction phase (Mt); data from EUROSTAT (2006)

Waste type	**Agriculture. hunting and forestry**	**Fishing**	**Mining and quarrying**	**Total**
Metallic wastes	0.15	0.01	0.58	0.74
Glass wastes	0.08	0	0	0.08
Paper and cardboard wastes	0.05	0	0.01	0.06
Plastic wastes	0.73	0.01	0.01	0.75
Wood wastes	2.1	0	0.03	2.13
Animal waste of food preparation and products	*2.88*	*0.02*	*0*	*2.9*
Other animal and vegetal wastes	*29.76*	*0.4*	*0.01*	*30.17*
Total bio-waste	**32.64**	0.42	0.01	33.07
Household and similar wastes	0.4	0.04	0.06	0.5
Mineral wastes (excluding combustion wastes. contaminated soils &polluted dredging spoils)	0.28	0	**736.73**	737.01

Two categories of waste are generated in a significant amount at the extraction phase: 32.64 Mt of bio-waste from agriculture, hunting and forestry, and 736.73 Mt of mineral waste from mining and quarrying.

5.2.3.2 Waste generated during production

Waste NACE codes D (excluding DN37, “Recycling”) correspond to manufacturing activity. The table below shows the amounts of waste generated by these industries, for each category of waste selected (Source: EUROSTAT).

Table 45: Waste generated during the production phase (Mt), data from EUROSTAT (2006)

Waste type	Manufacture of food products; beverages and tobacco	Manufacture of textiles and textile products. leather and leather products	Manufacture of wood and wood products	Manufacture of pulp. paper and paper products; publishing and printing	Manufacture of coke. refined petroleum products and nuclear fuel	Manufacture of chemicals. rubber and plastic products	Manufacture of other non-metallic mineral products	Manufacture of basic metals and fabricated metal products	Manufacture of machinery and equipment n.e.c... electrical and optical equipment. transport equipment	Manufacture of furniture; manufacturing n.e.c.	**Total production**
Metallic wastes	0.38	0.12	0.21	0.52	0.13	0.6	1.23	16.97	12.19	0.39	**29.16**
Glass wastes	0.65	0.01	0.02	0.04	0	0.07	1.29	0.06	0.16	0.02	**1.29**
Paper and cardboard wastes	1.82	0.31	0.1	11.68	0.01	0.75	0.19	0.4	1.31	0.26	**11.68**
Plastic wastes	0.56	0.16	0.05	0.3	0.01	1.68	0.07	0.14	0.43	0.09	**1.68**
Wood wastes	0.33	0.06	42.36	9.86	0.01	0.46	0.17	0.31	0.94	1.99	**54.21**
Animal waste of food preparation and products	*8.14*	*0.05*	*0*	*0*	*0*	*0.07*	*0*	*0*	*0*	*0*	***8.14***
Other animal and vegetal wastes	*29.16*	*0.03*	*0.03*	*0.02*	*0.02*	*0.55*	*0.01*	*0.02*	*0.05*	*0.03*	***29.16***
Total biowaste	37.3	0.08	0.03	0.02	0.02	0.62	0.01	0.02	0.05	0.03	**37.3**
Household and similar wastes	1.66	0.46	0.43	1.02	0.05	1.32	0.44	0.97	1.96	0.64	**0**
Mineral wastes (excluding combustion wastes. contaminated soils &polluted dredging spoils)	10.59	0.03	0.17	0.51	0.38	12.57	19.23	46.11	1.86	0.08	**19.23**

Not all waste generated by manufacturing industries can be classified as "production" waste.

For example, metallic waste from the manufacture of basic metals, fabricated metal products, and machinery and equipment (which are manly composed of metals) was identified as metal and metal products production waste. On the other hand, metal does not contribute to the production of paper products or plastic products for example. Metal waste generated by these industries cannot be classified as production waste.

For the purpose of this study, and to relate each waste stream the corresponding material flow, only waste that are clearly related to the production process of each industry are accounted for.

Unsurprisingly, the largest waste streams for a given material is generated by industries that manufacture these materials or products derived from these materials.

Mineral waste is an exception, as large amounts are generated by various industries. However, these streams were also excluded from the total "production waste", as they are not directly linked to the production of minerals or mineral products (mainly construction material).

5.2.3.3 End-of life waste

"End-of-life" waste is waste generated at the end of the life of a product or material, when it is discarded by its final user.

Activities described in NACE codes F (Construction), G to Q (services, excluding waste management activities G51.57 and O90) and HH (Households) are considered to be the main final users of materials and products. The table below presents the amounts of waste generated by these activities, for each category of waste selected.

Table 46: Waste generated at the end-of-life of materials (Mt), data from EUROSTAT (2006)

Waste type	Construction	Other economic activities (services) excluding 51.57 and 90	Households	**Total**
Metallic wastes	11.64	11.89	3.37	**26.9**
Glass wastes	0.54	3.98	7.23	**11.75**
Paper and cardboard wastes	1.58	25.06	16.68	**43.32**
Plastic wastes	2.79	5.03	2.17	**9.99**
Wood wastes	14.08	3.89	3.34	**21.31**
Animal waste of food preparation and products	*0*	*1.4*	*0.09*	***1.49***
Other animal and vegetal wastes	*0.6*	*10.17*	*23.26*	***34.03***
Total Food waste	0.6	11.57	23.35	**35.52**
Household and similar wastes	1.13	40.89	146.12	**188.14**
Mineral wastes (excluding combustion wastes. contaminated soils &polluted dredging spoils)	871.02	10.89	4.89	**886.8**

Household and similar wastes represent an important part of “end-of-life” waste, and therefore must be taken into account when estimating the waste prevention potential. However, as this stream is composed of various materials, EUROSTAT data does not allow establishing a clear link between this waste and the selected material flows. In order to fill this data gap, the European average composition of household waste, estimated by ACR+, was used. Base on this estimation, 75 % of the total household waste can be affected to individual material flows. The remaining 25 % is excluded from the assessment.

Table 47: Average composition of household waste (Source: ACR+)

Composition of household waste	Waste generated (Mt)	Fraction of total HH waste
Total (HH and services)	**188.1**	**100%**
Food	54.6	29%
Paper	48.9	26%
Plastics	16.9	9%
Glass	13.2	7%
Metals	7.5	4%
Total within scope	141.1	75%
Other or undefined material	47.0	25%

The table below shows how household and similar waste contribute to each.

Table 48: Breakdown of household waste into material categories (Mt)

Waste type	Construction	Other economic activities (services) excluding 51.57 and 90	Households	**Total**
Metallic wastes	0.05	1.64	5.84	**7.53**
Glass wastes	0.08	2.86	10.23	**13.17**
Paper and cardboard wastes	0.29	10.63	37.99	**48.92**
Plastic wastes	0.10	3.68	13.15	**16.93**
Wood wastes	0.00	0.00	0.00	**0.00**
Total biowaste	0.33	11.86	42.37	**54.56**
Household and similar wastes (other)	0.28	10.22	36.53	**47.04**
Mineral wastes (excluding combustion wastes. contaminated soils &polluted dredging spoils)	0.00	0.00	0.00	**0.00**

5.2.3.4 Synthesis

The table below summarises the results of the above analysis. It shows that the total waste taken into account by this analysis (column e, excluding household waste) cover more than 80 % of the total waste reported to EUROSTAT for each category (column f).

When accounting for household waste that can be affected to other waste categories, the total amounts to 2,101 Mt (column h), which represents 84% of the waste from the selected categories, and 75 % of the total waste reported to EUROSTAT (2,798 Mt, excluding secondary waste).

Table 49: Synthesis table, waste generated at each phase of the life cycle of materials (Mt), and coverage of the selected flows

Waste type	**Extraction waste.** Mt (a)	**Production waste.** Mt (b)	End of life waste. Mt (sorted) (c)	Total. Mt (excl. HH) (e=a+b+c)	Total. Mt (EUROSTAT excl. sec. waste) (f)	Representativeness (g = e/f)	**End of life waste.** Mt **(incl. HH)** (d)	Total. Mt (including HH) (h=a+b+d)
Metallic wastes	0.0	29.2	26.9	56.1	60.9	92%	7.5	**63.6**
Glass wastes	0.0	1.3	11.8	13.0	14.1	92%	13.2	**26.2**
Paper and cardboard wastes	0.0	11.7	43.3	55.0	60.4	91%	48.9	**103.9**
Plastic wastes	0.0	1.7	10.0	11.7	14.3	82%	16.9	**28.6**
Wood wastes	0.0	54.2	21.3	75.5	81.4	93%	0.0	**75.5**
Food waste	32.6	37.3	35.5	105.5	106.9	99%	54.6	**160.0**
Mineral waste	736.7	19.2	886.8	1642.8	1810.8	91%	0.0	**1642.8**
Total	**769.4**	**154.6**	**1035.6**	**1959.5**	**2346.7**	**84%**	**141.1**	**2100.6**

5.2.4 Conclusion: waste prevention potential

The above analysis has allowed differentiating waste streams at the European level, according to the material stream concerned and the life cycle stage that produces them. The potential for waste prevention mainly stands at two stages: production and end-of-life. Prevention of extraction waste will not be assessed here; the prevention potential at the production and end-of-life stage will be estimated by posing the simplest assumption that all waste is preventable.

5.2.4.1 Prevention of production waste

Production waste is waste generated during the manufacturing process of materials, either into elaborated materials or into products. Not all of the original material ends up in the final product, resulting in production losses.

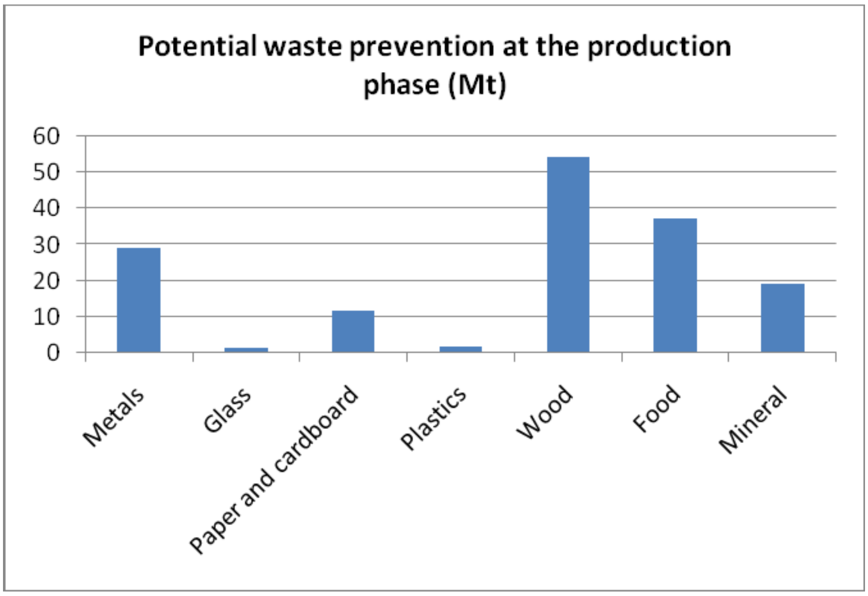
These production losses cannot be easily estimated for each material stream, as they highly depend on the subcategories of materials and the manufacturing processes. However, based on the production (or domestic extraction) figures and the waste data at the European level, average production losses can be broadly estimated for each category of material.

Table 50: Production losses for each material category

Material	Production or extraction (Mt)	*Production or extraction*	*Sources*	Production waste generation (Mt), EUROSTAT (2006)	Production losses, for 100% of virgin material produced
Metals	122	*Extraction*	*DE, EUROSTAT (2005)*	29,16	31%
Glass	31	*Production*	*CPIV Glass*	1,29	4%
Paper and cardboard	101	*Production*	*UNECE (2006)*	11,68	12%
Plastics	60	*Production*	*Plastics Europe (2008)*	1,68	3%
Wood	207	*Extraction*	*DE, EUROSTAT (2005); A.1.5.1 Timber (Industrial roundwood) (2005)*	54,21	35%
Food	674	*Extraction*	*DE, EUROSTAT (2005); A.1.1 Primary crops & A.1.6 Fish capture, crustaceans, molluscs and aquatic invertebrates & A.1.7 Hunting and gathering*	37,3	6%
Mineral	2921	*Extraction*	*DE, EUROSTAT (2005); A.3.1 to A.3.5, excl. extraction waste*	19,23	1%

The figure below illustrates the amount of waste that can be prevented at the production stage of the materials (assuming that all production waste is preventable).

Figure 62: Potential waste prevention at the production phase (Mt)

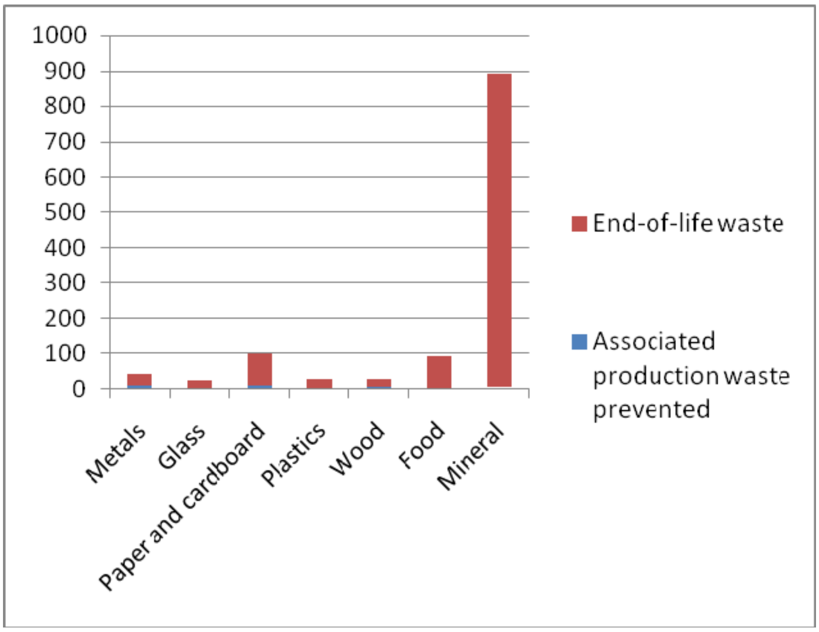


5.2.4.2 Prevention of end-of-life waste

Prevention at the end-of-life directly impacts the amount of waste generated at the end-of-life of the material, but also leads to the avoidance of production waste: to prevent 1 tonne of waste at the end-of-life also prevents the production of 1 tonne of material, and the generation of waste associated to this production. The potential of waste prevention at the end-of-life is also enhanced by the production loss factor (see table above).

The figure below illustrates the total amount of waste that can be prevented through prevention at the end-of-life.

Figure 63: Potential waste prevention at the end-of-life



5.3 Estimating the potential environmental benefits of waste prevention using a life cycle approach

5.3.1 Methodology

5.3.1.1 Life cycle data

In order to estimate average environmental impacts for the selected materials, material categories were split-up into subcategories for which specific LCA data was available. The average impact for each category was then deduced from various production or domestic extraction data, allowing the weighting of the subcategories into each category, as illustrated in the table below.

Table 51: Breakdown of material categories into subcategories for which specific LCA data is available

Category	Subcategory	Production or DE (Mt or %)	Sources and assumptions	Breakdown
Metals	Aluminium	3,1	DE, EUROSTAT (2005)	3%
	Copper	59	DE, EUROSTAT (2005)	62%
	Lead	4,9	DE, EUROSTAT (2005)	5%
	Steel	28	DE, EUROSTAT (2005)	29%
	Others	27	Calculation	
	Total	122	DE, EUROSTAT (2005)	

Glass	Construction glass	9,1	CPIV Glass	31%
	Glass fibre	0,5	CPIV Glass	2%
	Packaging glass	19,3	CPIV Glass	67%
	Others	2,1	Calculation	
	Total	31	CPIV Glass	
Mineral	Clay	124	DE, EUROSTAT (2005)	4%
	Concrete	1350	Production of ready-mixed and precast concrete, BIOIS (2008)	39%
	Gypsum	44	Production of gypsum, BIOIS (2008)	1%
	Limestone	677	DE Limestone and Gypsum, EUROSTAT (2005), minus gypsum production	20%
	Gravel	621,5	DE gravel and sand, EUROSTAT (2005), assuming 1 350 Mt of sand and gravel used in concrete, and a 50%/50% repartition between sand and gravel	18%
	Sand	621,5	DE gravel and sand, EUROSTAT (2005), assuming 1 350 Mt of sand and gravel used in concrete, and a 50%/50% repartition between sand and gravel	18%
	Others	220	Calculation	
	Total	3658	DE, EUROSTAT (2005)	
Wood	Wood	207	DE, EUROSTAT (2005)	100%
Biomass	Corn	55,4	Production, EUROSTAT (2006)	13%
	Potato	56,8	Production, EUROSTAT (2006)	13%
	Wheat	126,6	Production, EUROSTAT (2006)	30%
	Beef	8,2	Bovine meet, slaughtered weight, 2004 (JRC)	2%
	Pork	22	Pork, slaughtered weight, 2004 (JRC)	5%
	Milk	153	Dairy products, raw milk equivalents, 2004 (JRC)	36%
	Total	422	Calculation	
Paper	Graphic paper	48	UNECE, graphic paper	48%
	Packaging paper	8,3	UNECE, packaging paper and other paper, mainly for packaging	8%
	Newsprint paper	10	UNECE, newsprint paper	10%
	Cardboard	33,9	UNECE, cases material and folding boxboard	34%
	Others	0,8	Calculation	
	Total	101	UNECE, paper and cardboards	
Plastics	PET	7%	PlasticsEurope, demand by plastics, 2008	9%
	HDPE	11%	PlasticsEurope, demand by plastics, 2008	14%
	LDPE, LLDPE	17%	PlasticsEurope, demand by plastics, 2008	21%
	PUR	7%	PlasticsEurope, demand by plastics, 2008	9%
	PP	18%	PlasticsEurope, demand by plastics, 2008	23%
	Polystyrene	8%	PlasticsEurope, demand by plastics, 2008	10%
	PVC	12%	PlasticsEurope, demand by plastics, 2008	15%
	Others	20%	PlasticsEurope, demand by plastics, 2008	

Life cycle inventories were extracted from the EcoInvent database. The detail of the LCI used is presented in annex.

5.3.1.2 Life Cycle Impact Assessment (LCIA) methodology and environmental indicators

Four CML indicators were evaluated for this analysis:

- Greenhouse gases emissions (CO_2 eq.)
- Resource depletion (S_b eq.)
- Acidification potential (SO_2 eq.)
- Eutrophication potential (PO_{43}- eq.)

5.3.1.3 Estimation of the benefits of waste prevention

The potential environmental benefits from waste prevention were calculated using the following formulas, for each indicator.

Equation 3: Environmental benefits from the prevention of 1 tonne of production waste

$$l = R_r * l_r + (1 - R_r) * l_v + R_i * l_i + R_l * l_l$$

With:

R_r : recycling rate

R_i : incineration rate[60]

R_l : landill rate

I_r : impact of recycled material

I_v: impact of virgin material

I_i: impact of inceration

I_l: impact of landfilling

Equation 4: Environmental benefits from the prevention of 1 tonne of end-of-life waste

$$l = (1 + P_l) * (R_r * l_r + (1 - R_r) * l_v + R_i * l_i + R_l + l_l) + l_t$$

With:

P_l: production losses (%)

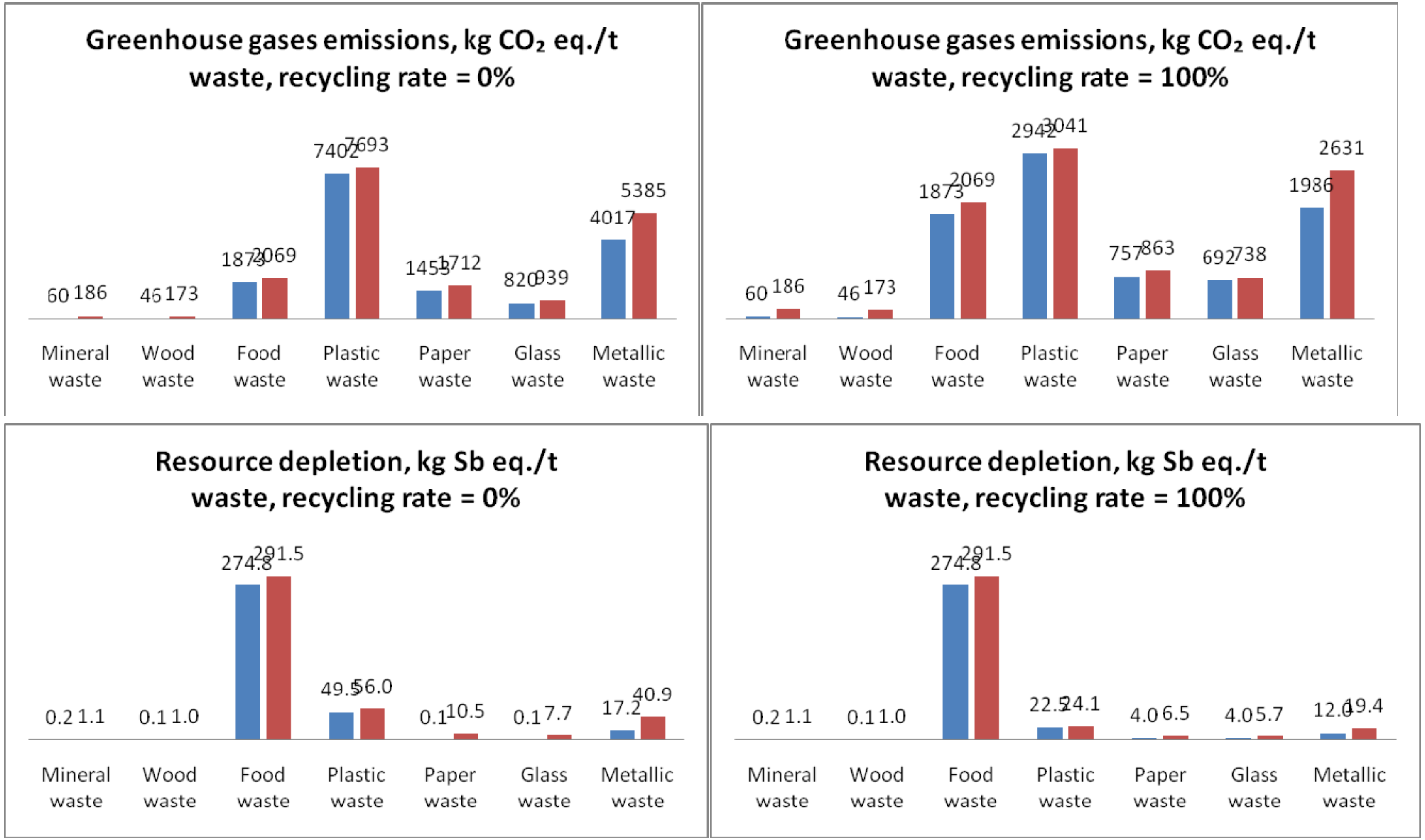
I_t: Impact of transportation (from the manufacturing plant to the consumer)

The results presented in the next paragraph were obtained by testing and comparing two “extreme” scenarios. In one case, recycling rates are assumed to be 0% for all materials, in the second one, all “recyclable” materials are assumed to be 100 % recycled (it was assumed that wood waste, food waste and mineral waste are not recycled in this scenario). This comparison aims at comparing the relative benefits of prevention in a society where nothing is recycled and in a “recycling society”.

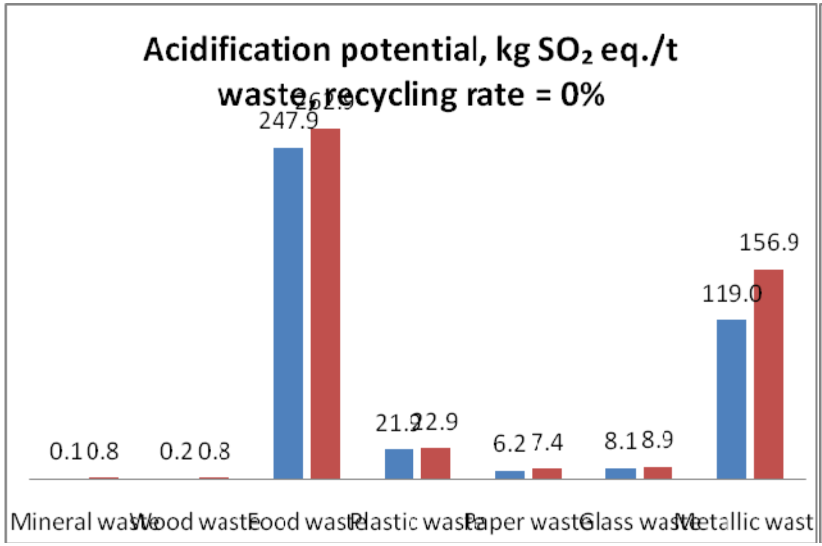
[60] For simplification purposes, non recycled waste was assumed to be either equally incinerated or landfilled for non inert waste (wood, food, paper and plastics) or 100% landfilled for inert waste (metals, minerals and glass)

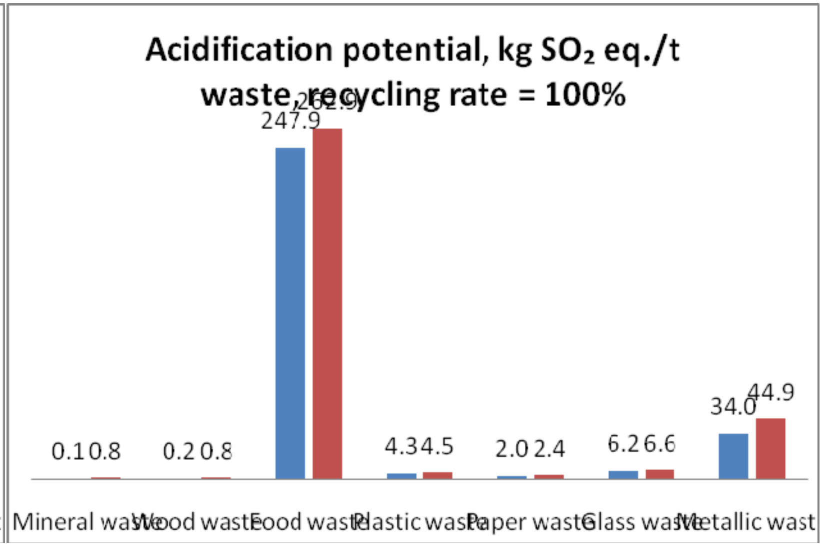
5.3.2 Results

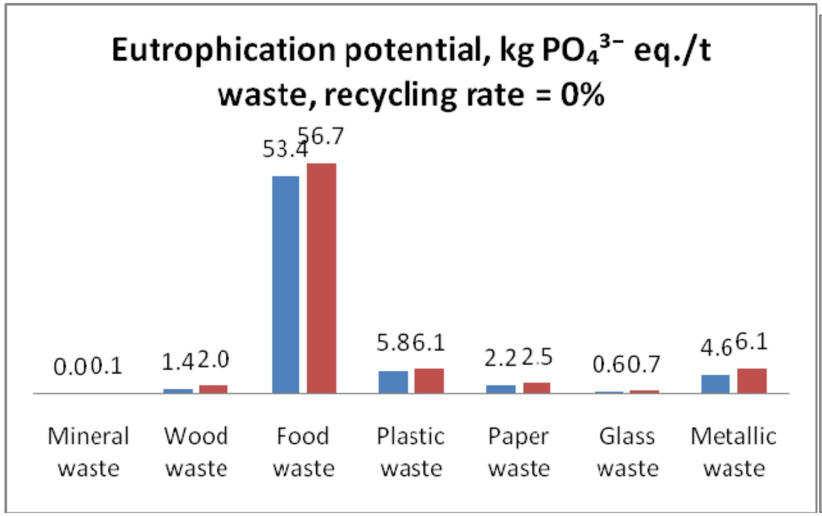
5.3.2.1 Potential benefits per tonne of waste prevented

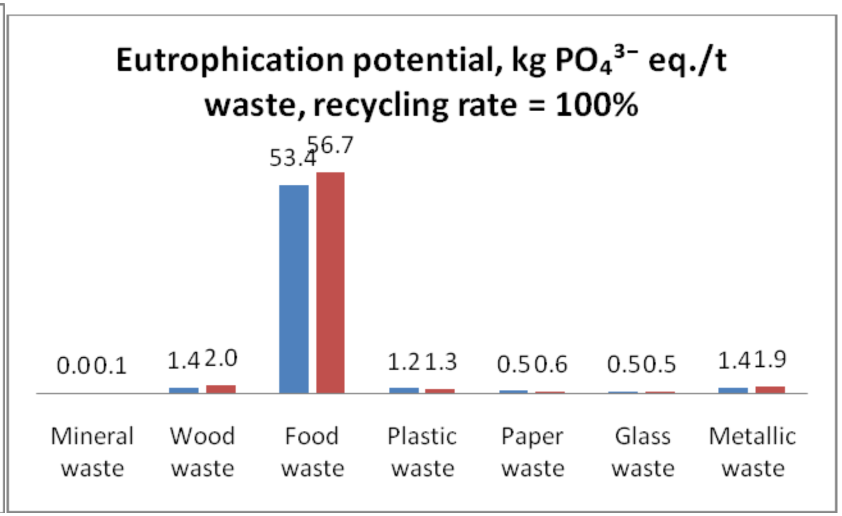


Blue bars: potential benefits from preventing production waste, red bars: potential benefits from preventing end-of-life waste



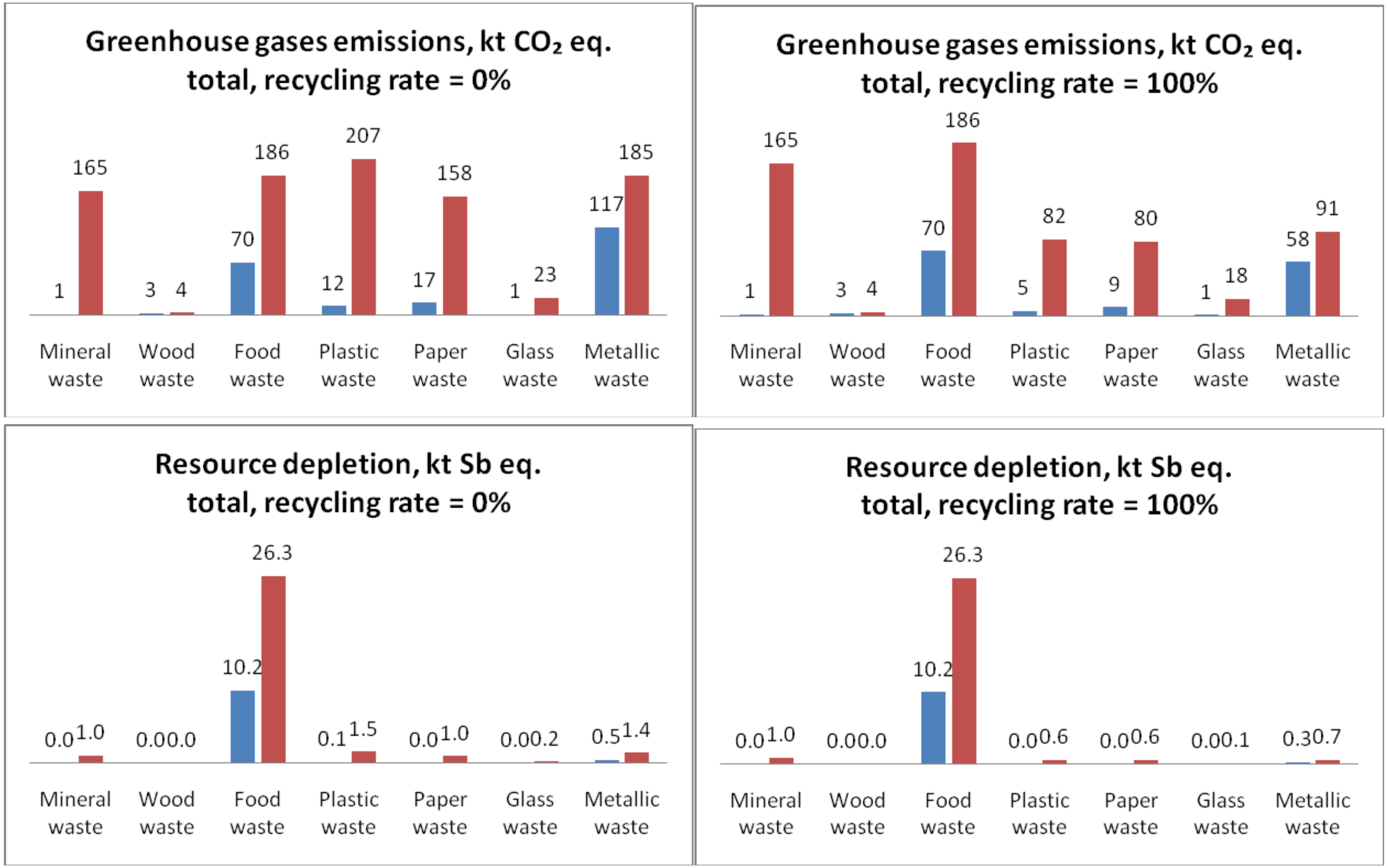




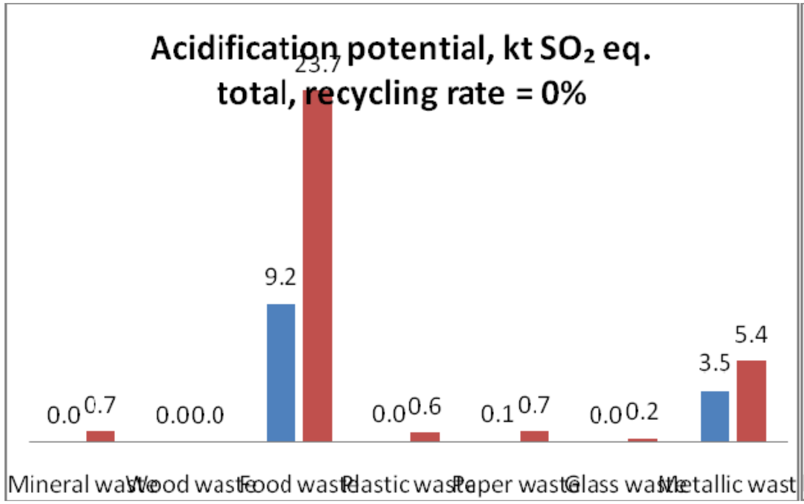


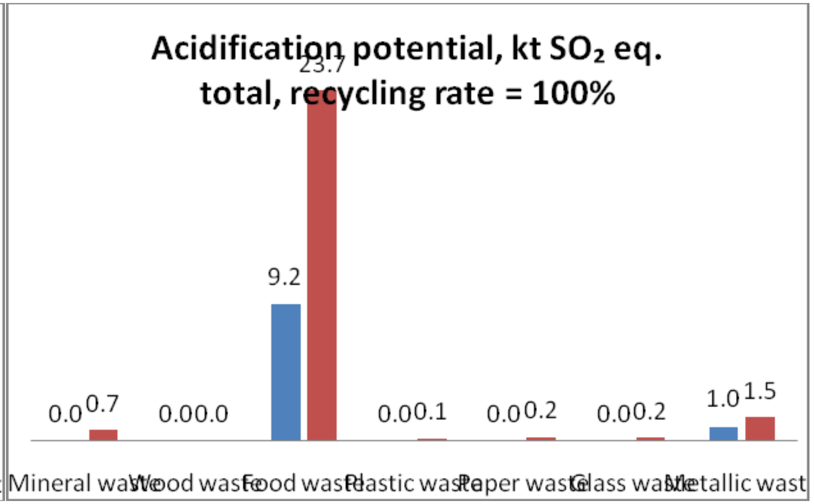
Blue bars: potential benefits from preventing production waste, red bars: potential benefits from preventing end-of-life waste

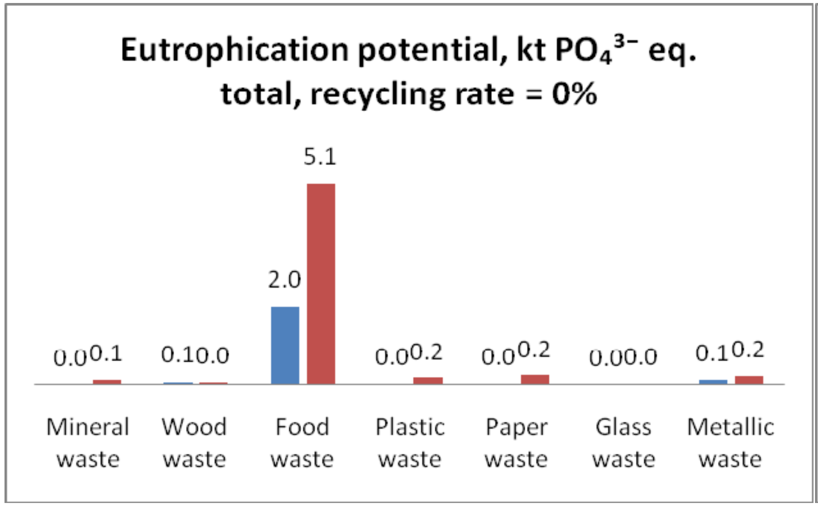
5.3.2.2 Total potential benefits per material category

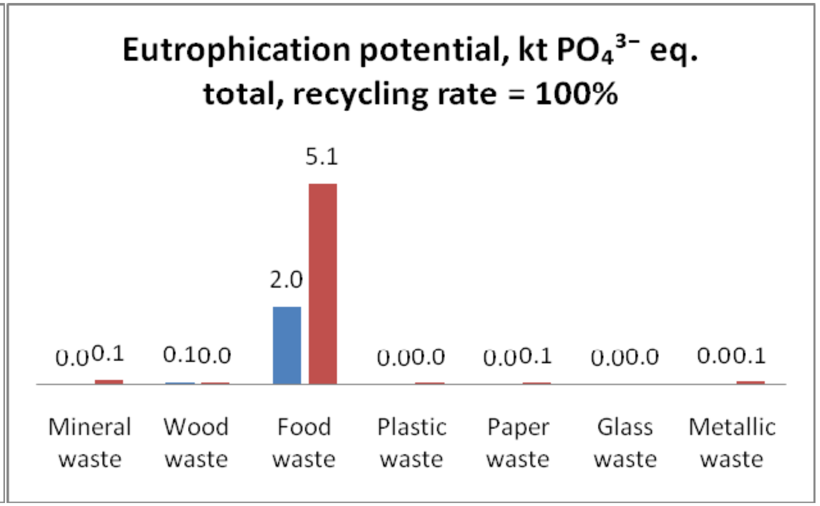


Blue bars: potential benefits from preventing production waste, red bars: potential benefits from preventing end-of-life waste


Acidification potential, kt SO₂ eq.
total, recycling rate = 0%
0.0 0.7
0.0 0.0
9.2 23.7
0.0 0.6
0.1 0.7
0.0 0.2
3.5 5.4
Mineral waste
Wood waste
Food waste
Plastic waste
Paper waste
Glass waste
Metallic waste


Acidification potential, kt SO₂ eq.
total, recycling rate = 100%
0.0 0.7
0.0 0.0
9.2 23.7
0.0 0.1
0.0 0.2
0.0 0.2
1.0 1.5
Mineral waste
Wood waste
Food waste
Plastic waste
Paper waste
Glass waste
Metallic waste


Eutrophication potential, kt PO₄³⁻ eq.
total, recycling rate = 0%
0.0 0.1
0.1 0.0
2.0 5.1
0.0 0.2
0.0 0.2
0.0 0.0
0.1 0.2
Mineral waste
Wood waste
Food waste
Plastic waste
Paper waste
Glass waste
Metallic waste


Eutrophication potential, kt PO₄³⁻ eq.
total, recycling rate = 100%
0.0 0.1
0.1 0.0
2.0 5.1
0.0 0.0
0.0 0.1
0.0 0.0
0.0 0.1
Mineral waste
Wood waste
Food waste
Plastic waste
Paper waste
Glass waste
Metallic waste

5.3.3 Conclusions

The comparison of potential benefits of waste prevention per tonne of waste prevented (5.3.2.1) shows few differences between preventing production and end-of-life waste. This is due to the fact that, from a material perspective, most of the environmental impacts occur during the extraction and manufacturing. Slightly higher environmental benefits from preventing one tonne of end-of-life waste are mainly due to the avoided transportation of the material from the manufacturer to the consumer.

From a product perspective, it is likely that benefits from prevention end-of-life waste are even higher, especially for elaborated products, involving several manufacturing steps from the raw material to the final product.

It is interesting to note that benefits from waste prevention (either at the production or end-of life stage) are significantly lower for recyclable material in the 100% recycling scenario.

In terms of GHG emissions, the highest benefits are obtained from preventing one tonne of plastic waste, followed by metallic waste and food waste, then paper and glass waste. Preventing one tonne of bio-waste represents by far the highest benefits on the three other indicators (acidification, eutrophication and resource depletion).

Prevention of end-of-life waste shows relatively much higher benefits compared to prevention of production waste when observing the total potential benefits (5.3.2.2).

In terms of GHG emissions, 5 waste streams represent comparable potential benefits, despite of the very different volumes generated: minerals, food, plastics, paper and metals. At the production phase, metals and food represent the highest potential benefits.

Regarding the three other environmental indicators studied, food waste shows by far the highest potential benefits, both at the production and end-of-life phases.

6 Task 4: Identification of areas for intervention

6.1 Matrix of high potential areas

6.1.1 Detailed approach

In order to identify the areas presenting the highest potential, very different aspects need to be compared with each other. Often these aspects are expressed using different quantitative, qualitative or semi-quantitative indicators. The approach selected for the comparison of options (in this case the comparison of possible high potential areas) is a multi-criteria analysis (MCA). A MCA focuses on increasing the insight in the actual deliberative process. An MCA stimulates an interactive decision making process. The weight attributed to the different criteria corresponds to the importance the decision makers ascribe to the criteria. The outcome of an MCA exercise is largely dependant on the allocation of weights to the different decision criteria. The strength of MCA relates to the comparison of very heterogeneous information which either can not be monetised or for which monetisation is not desirable.

Two fundamental questions have to be solved to identify the areas of high potential for waste prevention:

- What are the most promising material flows?
- What are the most promising prevention strategies to apply on these waste streams?

This information obtained has to be checked with a third question; which policy strategies are compatible, or can überhaupt be combined with which material or waste streams.

STEP 1: use a multi criteria analysis to identify the most promising material flows.

- Material flows on which in the previous chapters information has been collected are analysed. These are broad categories that together will cover a large fraction of the material economy. They include : mineral, wood, bio-waste, plastics, paper and cardboard, glass, metals, hazardous, household (MSW)

  The material flows considered are those for which reliable data are available, covering a large fraction of all waste generated in the EU. To be consistent with the MCA methodology categories have to be selected in a way that they are mutually exclusive. This has been achieved for all waste categories, except for two more horizontally defined categories 'hazardous waste' and 'municipal solid waste'. These fractions may in theory contain metals, plastics, glass, wood etc… However they can be considered as individual fractions as the quantities are based on EUROSTAT data from the Waste Statistics Regulation. The reported quantities for metals, plastics etc… only include individually reported fractions, and not the materials mixed up in mixed household waste or hazardous waste.

- On each material flow three sets of independent evaluation questions have been answered;
  - on potential for quantitative prevention
    - What is the amount of direct waste generation, based on data collected in chapters 4.4 (Quantitative description of current

status of waste flows) and 4.7 (Comparison of waste data & material flow data).

- Where can important amounts of hidden material or waste flows be expected, based on data and analyses in chapter 4.6 (Material flows in the economy), assessment of hidden flows, and material resource depletion
- Which waste streams have a tendency to, rise or to decline? Future trends based on chapter 4.5 (Near future development of waste generation and prevention)

- on potential for qualitative prevention
  - hazardousness of materials and waste, the probability of the material to contain hazardous products or components
- on life cycle aspects.
  - Impact of the material on resource depletion, taking into account scarcity, future availability and import dependence
  - Impact of the material on greenhouse gasses emissions
  - acidification potential of the material
  - eutrophication potential of the material

  All data are retrieved from chapter 5.3 (Estimating the potential environmental benefits of waste prevention using a life cycle approach).

The evaluation questions will be approached in an EU-wide perspective, and result in a ranking and scoring of materials

STEP 2: use a multi criteria analysis to identify the most promising strategies

- The strategies are retrieved from the visual map designed in chapter 3.5 (Visual map for waste prevention strategies).
  - awareness, education and other information
  - ecodesign
  - extended producer responsibility
  - green public procurement
  - labeling / certification
  - marketing
  - positive and negative financial stimuli
  - prevention targets
  - product standards
  - reuse
  - technology standards
  - voluntary agreements
- For each strategy four sets of independent evaluation questions have been answered
  - on efficiency

    - technical effectiveness; how technically effective is the instrument in generating waste prevention, is it stimulating eco-efficient products and services
    - implementation costs; what are the costs to implement the instrument?
  - on feasibility
    - political feasibility; is there a political will to implement the instrument, available institutional capacity.
    - administrative feasibility/burden & transaction costs; what is the administrative burden, and what are the transaction costs.
    - legally binding / enforceable; can the implementation of the instrument be enforced through legal means, or do authorities have no enforcing impact: obligations, bans …
    - field experience; to what extent has the policy been used already before?
  - on life cycle phase
    - On what phase of the life cycle of a product has the instrument its impact: design, raw materials, production, distribution + private and public consumption, waste & post waste.
  - on societal aspects.
    - Fairness; is the instrument in line with the polluter pays principle?
    - technological innovation; can the instrument stimulate in a direct way technological innovation on lean, clean and efficient production

The evaluation questions will be approached in an EU-wide perspective, they will result in a ranking and scoring of strategies.

STEP 3: combine both results

The sum of the score for the material and the score of the strategy is made and represented in a matrix. High scorers are areas of high potential for waste prevention with a high scoring waste stream combined with a high scoring policy strategy.

STEP 4: it is clear that not every strategy can with the same level of success be combined with every material stream. Eco-design can be very successful on hazardous materials and wastes, but less successful on paper. To take these issues into account a matrix will be developed with for each combination material- strategy a classification on: no fit / weak fit / strong fit.

STEP 5: the result of step 3 and of step 4 is combined together, which leads to the final outcome: a matrix of high potential areas. The result is illustrated by key examples.

An excel worksheet has been developed which contains in a central page the weighing factors and the MCA calculation, and in the next pages the motivated scores for the different evaluation questions.

A standard multi-criteria analysis is composed of the following steps:

- The phrasing of the question is developed in detail. In casu: What are the most promising material flows? What are the most promising prevention strategies to apply on these waste streams?
- The criteria that are used to answer this question are defined in a way to make an independent evaluation of each criterion possible. In other words the criteria may not depend upon each other. Of course it is challenging to realise this for all criteria. Criteria are divided into sub-criteria.
- Weights are attributed to the criteria, both to the main criteria and the sub-criteria. This exercise is realised in deliberation with the Commission, as it is partially a policy decision.
- Each criterion is scored in a comparable way: all scores are recalculated to an ordinal scale of 0 to 5. All scores need to be formulated in a positive way, which means that negative evaluations are translated as a positive effect. Avoiding a negative effect is a positive effect. One of the options to be investigated always receives the maximum score, to avoid that the scores have an impact on the attributed weights of the criteria.
- Of course scoring is often a policy decision as well, on which deliberation and/or approval is needed. Some scores are of course no policy decision, but can be calculated from quantitative data.
- The results are weighed and summarised, first within each main criterion, and then over all criteria. This results in an indicator for the desirability of a proposed selection.

6.1.2 Motivation of the weighing factors

Weighing factors are an expression of how policy makers value the importance of the different evaluation questions.

Table 52: Weighing factors for evaluation questions in the MCA on materials

	weight head criterium	weight subcriterium
I quantitative prevention	***30***	
I.a amount of direct waste generation		*50*
I.b hidden material or waste flows		*30*
I.c future trends		*20*
II qualitative prevention	***30***	
II.a hazardousness of materials and waste		*100*
III life cycle aspects	***40***	
III.a resource depletion		*35*
III.b greenhouse gasses emissions		*35*
III.c acidification potential		*15*
III.d eutrophication potential		*15*

Table 53: Weighing factors for evaluation questions in the MCA on strategies

	weight head criterium	weight subcriterium
I efficiency of instrument	***35***	
I.a technical effectiveness		70
I.b implementation costs		30
II feasibility	***30***	
II.a political feasibility		30
II.b administrative feasibility/burden & transaction costs		20
II.c legally binding / enforceable		35
II.d field experience		15
III life cycle phase	***15***	
III.a phase in life cycle		100
IV societal aspects	**20**	
IV.a fairness (cfr. polluter pay principle)		70
IV.b technological innovation		30

6.1.3 MCA on material and waste flows

6.1.3.1 Scoring the evaluation questions

Evaluation question I.a: amount of direct waste generation:

	stream question I.A: amount of direct waste generation					
	tons of generated waste					
		measured		revised	recalculated	source in report
1	mineral	2724	Mt	2724	5,00	Chapter 4.7 overview of the average mineral input (2000-2005) and related waste output (2004 & 2006) of the EU27
2	wood	84,1	Mt	168,2	0,31	chapter 4.4 Total waste generation in EU-27 by EWCStat-Waste Category (part 1) in 2006 (derived from EUROSTAT 2009a)
3	bio-waste	415	Mt	415	0,76	Chapter 4.7 overview of the average biomass input (2000-2005) and related waste output (2004 & 2006) of the EU27
4	plastics	86	Mt	86	0,16	Chapter 4.7 overview of the average fossil fuel input (2000-2005) and related waste output (2004 & 2006) of the EU27
5	paper and cardboard	90,3	Mt	180,6	0,33	chapter 4.4 Total waste generation in EU-27 by EWCStat-Waste Category (part 1) in 2006 (derived from EUROSTAT 2009a) + packaging waste generation in EU-27 in 2006 (derived from EUROSTAT 2009a)
6	glass	32,3	Mt	64,6	0,12	chapter 4.4 Total waste generation in EU-27 by EWCStat-Waste Category (part 1) in 2006 (derived from EUROSTAT 2009a) + packaging waste generation in EU-27 in 2006 (derived from EUROSTAT 2009a)
7	metals	111,52	Mt	111,52	0,20	chapter 4.4 Total waste generation in EU-27 by EWCStat-Waste Category (part 1) in 2006 (derived from EUROSTAT 2009a) + packaging waste generation in EU-27 in 2006 (derived from EUROSTAT 2009a)
8	hazardous	89	Mt	89	0,16	chapter 4.4 generation of total waste in EU-27 hazardous and non hazardous (derived from EUROSTAT 2009a)
9	household (MSW)	218	Mt	218	0,40	chapter 4.4 total waste generation in EU-27 bt secror/branche in 2006 (derived from EUROSTAT 2009a)

data are preferably retrieved from chapter 4.7 material flows in the economy

data retrieved from EUROSTAT based on EWCStat categories (chapter 4.4) are only a proxy as they describe only the pure waste fractions and not the materials included in other waste fractions e.g. only the pure plastics and not the plastics included in mixed household waste, ELV, WEEE, packaging etc…

the highest value in both datasets is used. If only the EWCStat dataset exists and it can be presumed that the material is present in other waste categories as well, the measured value is augmented with a factor 2 (on the order of 2, educated guess)

comparison

	chapter 4.6	chapter 4.4		comparison (%)
mineral	2724	1794	mineral	151,84
bio-waste	415	111,4	animal and vegetal wastes + animal waste from food	372,53
plastics	86	26,4	plastics acc. EWCStat + plastic packaging	325,76
metals	68	101,9	metallic waste	66,73

Evaluation question I.b: amount of hidden flows

	stream question I.B: amount of hidden flow			
	assessment of hidden flows, and material resource depletion (from not relevant tot highly present)			
		assessed	motivation	source
1	mineral	1,50	large quantities of domestic extraction with potentially hidden flows as unised domestic extraction	Chapter 4.7 overview of the average mineral input (2000-2005) and related waste output (2004 & 2006) of the EU27
2	wood	2,00	wood consumption depending on wood import from tropical areas, where its harvesting causes hidden flows	
3	bio-waste	1,00	limited hidden flows except for fishery	
4	plastics	2,00	hidden flows linked to foreign extraction and import of fossil fuels	Chapter 4.7 overview of the average fossil fuel input (2000-2005) and related waste output (2004 & 2006) of the EU27
5	paper and cardboard	2,00	paper production depending on wood domestic extraction and import, where its harvesting causes hidden flows	
6	glass	0,50	limited apparent hidden flows	
7	metals	5,00	hidden flows linked to foreign mining and import of ores or semimanufactured articles	Chapter 4.7 overview of the average metal input (2000-2005) and related waste output (2004 & 2006) of the EU27 Bringezu St. & Bleischwitz R. (2009): Sustainable Resource Management - Global Trends, Visions and Policies. Greenleaf Publishing, Sheffield, UK.
8	hazardous	4,50	hidden flows linked to foreign extraction and import of raw materials for chemistry and heavy metals	
9	household (MSW)	3,00	The same hidden flows which are connected to the other waste streams are also valid for household waste, so the	
	hidden flows are:			
	Unused domestic extraction (Hidden Flows): Materials that are moved on a nation's territory on purpose and by means of technology but are not fit or intended for use. Unused domestic extraction include such as soil and rock excavated during construction, dredged sediments from harbours, overburden from mining and quarrying and unused biomass from harvest.			
	Indirect flows associated to imports (Hidden flows of imports): Direct inputs used and unused extraction generated abroad in producing products for export but which are not included in the quantities of exported raw materials and manufactured products.			
	Indirect flows associated to exports (Hidden flows of exports): Defined correspondingly to Hidden flows of imports			

Evaluation question 1.c: future trends

stream question I.C: future trends

assessment of future trends, waste streams apparently increasing, remaining stable, decreasing

		assessed	motivation
1	mineral	5,00	mineral waste is assessed to grow in line with the generation of the total amount of non household waste. However source separated selection of this fraction and thus recyclability is expected to grow at a much higher speed
2	wood	5,00	wood waste is assessed to grow in line with the generation of the total amount of non household waste
3	bio-waste	3,06	gaining importance in MSW
4	plastics	2,73	losing importance in MSW
5	paper and cardboard	3,22	gaining importance in MSW
6	glass	2,88	losing importance in MSW
7	metals	2,89	metal waste is assessed to grow in line with the generation of the total amount of non household waste
8	hazardous	5,00	hazardous waste (as it is generally non household waste) is assessed to grow in line with the generation of the total amount of non household waste
9	household (MSW)	3,00	set at three

The evolution of different fractions of waste is largely assessed based on the trends assessed for the composing fractions of waste generated by households

In this approach no account is taken of extraction or production waste, but the evolution of these non-household fractions is assumed to be in line with the generation of the end-of-use consumer waste fraction.

non household waste fractions (like wood, mineral and to a degree metal) is assessed in line with the expected large growth rate for the sum of industrial and non household waste.

household waste is growing to 112% from 2005 to 2020; this is given the value 3

non household or industrial waste is growing to 161% from 2006 to 2020, this is given the value 5

	MSW:								
	bio waste	paper and c	plastics	glass	metals	other	TOTAL	non household	
2005	90.377.574	42.914.042	16.353.182	15.599.986	5.359.025	83.179.713	253.783.521		
2006	91.565.104	44.139.816	16.456.384	15.791.278	5.267.345	84.305.912	257.525.839	2006	2806533
2007	92.790.283	44.987.400	16.539.075	15.976.181	5.332.762	85.365.586	260.991.287	2007	2941470
2008	93.267.446	45.219.553	16.614.744	16.051.535	5.358.383	85.771.225	262.282.886	2008	2941470
2009	93.237.324	45.207.063	16.607.371	16.043.537	5.356.674	85.735.736	262.187.705	2009	2941470
2010	94.471.003	46.171.551	16.702.570	16.227.271	5.417.094	86.738.222	265.727.711	2010	3084634
2011	95.721.659	47.218.437	16.794.451	16.415.307	5.479.428	87.743.703	269.372.985	2011	3212030
2012	97.000.756	48.365.314	16.880.976	16.592.394	5.526.137	88.591.869	272.957.446	2012	3346046
2013	98.307.512	49.624.108	16.965.251	16.775.991	5.573.593	89.440.874	276.687.329	2013	3487083
2014	99.428.926	50.886.991	17.031.916	16.870.549	5.632.817	90.110.417	279.961.616	2014	3635567
2015	100.571.649	51.123.027	17.090.720	16.943.227	5.671.657	90.584.291	281.984.571	2015	3791951
2016	101.737.264	51.278.186	17.146.935	17.013.361	5.696.129	91.045.982	283.917.857	2016	3924850
2017	102.927.543	51.424.255	17.200.104	17.080.538	5.712.349	91.493.152	285.837.941	2017	4063523
2018	103.248.491	51.562.482	17.246.652	17.126.411	5.727.699	91.739.440	286.651.175	2018	4208254
2019	103.551.071	51.691.636	17.290.164	17.169.273	5.742.040	91.969.585	287.413.769	2019	4359345
2020	103.803.472	51.812.392	17.330.860	17.209.347	5.755.448	92.184.777	288.096.296	2020	4517111
2021	104.019.288	51.924.611	17.368.694	17.246.592	5.767.909	92.384.775	288.711.869	2021	4642336
2022	104.217.622	52.028.249	17.403.657	17.280.987	5.779.416	92.569.502	289.279.433	2022	4771814
2023	104.398.451	52.122.968	17.435.633	17.312.425	5.789.932	92.738.357	289.797.766	2023	4905707
2024	104.562.091	52.208.965	17.464.687	17.340.970	5.799.479	92.891.690	290.267.882	2024	5044182
2025	104.710.690	52.287.232	17.491.150	17.366.953	5.808.169	93.031.260	290.695.454	2025	5187415
2026	104.844.521	52.357.711	17.515.005	17.390.353	5.815.993	93.156.971	291.080.554	2026	5335587
2027	104.963.798	52.420.833	17.536.396	17.411.313	5.823.000	93.269.590	291.424.930	2027	5488887
2028	105.069.275	52.476.662	17.555.343	17.429.855	5.829.197	93.369.224	291.729.556	2028	5647512
2029	105.163.725	52.526.505	17.572.282	17.446.415	5.834.729	93.458.206	292.001.862	2029	5811666
2030	105.247.531	52.570.521	17.587.267	17.461.042	5.839.615	93.536.809	292.242.785	2030	5981561
2006-2020 evolution (%)	113,37	117,38	105,31	108,98	109,27	109,35	111,87		160,9498
value	3,1	3,2	2,7	2,9	2,9	2,9	3,0		5,0

Evaluation question II.a: hazardousness of material and waste

	stream question II.A: hazardousness of materials and waste		
	based on expert opinion and composition data where available		
		assessed	motivation
1	mineral	1,00	mineral waste is not hazardous, except for a minimal fraction of asbestos, or except for possible hazaredous pollutants that may leach from it
2	wood	2,00	wood waste, although often not hazardous 'in se', may be contaminated by wood preservatives that can contain hazardous substances
3	bio-waste	0,00	bio-waste is not hazardous
4	plastics	2,00	plastic waste is generally non hazardous but it may be contaminated by flame retardants or other additives that can consist of hazardous substances
5	paper and cardboard	0,00	paper waste is not hazardous
6	glass	1,00	glass waste is not hazardous except for fractions of leaded glass or activated glass from EEE
7	metals	4,00	while iron, aluminium, copper and zinc are non hazardous, many alloy-metals used in steel and most of the other metals used in electric and electronic equipment, batteries and cars are hazardous.
8	hazardous	5,00	defined as waste containing hazardous substances
9	household (MSW)	3,00	MSW contains a fraction of hazardous municipal waste (or small hazardous waste)

Evaluation question III.a: resource depletion

	stream question III.A: resource depletion	
		assessed
1	mineral	0,01
2	wood	0,01
3	bio-waste	5,00
4	plastics	0,67
5	paper and cardboard	0,09
6	glass	0,08
7	metals	0,40
8	hazardous	0,89
9	household (MSW)	0,89

expressed in kg Sb eq./t waste. Average between recycling rate 0% and recycling rate 100%
chapter 5.3

no data are available for the mixed categories municpal waste and hazardous waste. In order not to distort the MCA average values are assumed

	recycling rate 0%		recycling rate 100%		average	
	production	end of life	production	end of life		
mineral	0,20	1,10	0,20	1,10	0,65	0,01
wood	0,10	1,00	0,10	1,00	0,55	0,01
bio-waste	274,80	291,50	274,80	291,50	283,15	5,00
plastics	49,50	56,00	22,50	24,10	38,03	0,67
paper and cardboard	0,10	10,50	4,00	6,50	5,28	0,09
glass	0,10	7,70	4,00	5,70	4,38	0,08
metals	17,20	40,90	12,00	19,40	22,38	0,40
hazardous	48,86	58,39	45,37	49,90	50,63	0,89
household (MSW)	48,86	58,39	45,37	49,90	50,63	0,89

Evaluation question III.b: greenhouse gasses emissions

	stream question III.B: greenhouse gasses emissions						
		assessed					
1	mineral	0,12					
2	wood	0,10					
3	bio-waste	1,87					
4	plastics	5,00					
5	paper and cardboard	1,14					
6	glass	0,76					
7	metals	3,25					
8	hazardous	1,75					
9	household (MSW)	1,75					

expressed in kg CO2 eq./t waste. Average between recycling rate 0% and recycling rate 100%
chapter 5.3

no data are available for the mixed categories municpal waste and hazardous waste. In order not to distort the MCA average values are assumed

	recycling rate 0%		recycling rate 100%		average	
	production	end of life	production	end of life		
mineral	60,00	186,00	60,00	186,00	123,00	0,12
wood	46,00	173,00	46,00	173,00	109,50	0,10
bio-waste	1873,00	2069,00	1873,00	2069,00	1971,00	1,87
plastics	7402,00	7693,00	2942,00	3041,00	5269,50	5,00
paper and cardboard	1453,00	1712,00	757,00	863,00	1196,25	1,14
glass	820,00	939,00	692,00	738,00	797,25	0,76
metals	4017,00	5385,00	1686,00	2631,00	3429,75	3,25
hazardous	2238,71	2593,86	1150,86	1385,86	1842,32	1,75
household (MSW)	2238,71	2593,86	1150,86	1385,86	1842,32	1,75

Evaluation question III.c: acidification potential

	stream question III.C: acidification potential						
		assessed					
1	mineral	0,01					
2	wood	0,01					
3	bio-waste	5,00					
4	plastics	0,26					
5	paper and cardboard	0,09					
6	glass	0,15					
7	metals	1,74					
8	hazardous	0,38		average of all fractions except bio-waste			
9	household (MSW)	1,67		one third of bio waste, because of the assessed composition of MSW			
	expressed in kg SO2 eq./t waste. Average between recycling rate 0% and recycling rate 100% chapter 5.3						
	no data are available for the mixed categories municpal waste and hazardous waste. In order not to distort the MCA average values are assumed						
		recycling rate 0%		recycling rate 100%		average	
		production	end of life	production	end of life		
	mineral	0,10	0,80	0,10	0,80	0,45	0,01
	wood	0,20	0,80	0,20	0,80	0,50	0,01
	bio-waste	247,90	262,90	247,90	262,90	255,40	5,00
	plastics	21,90	22,90	4,30	4,50	13,40	0,26
	paper and cardboard	6,20	7,40	2,00	2,40	4,50	0,09
	glass	8,10	8,90	6,20	6,60	7,45	0,15
	metals	119,00	156,90	34,00	44,90	88,70	1,74
	hazardous	25,92	32,95	7,80	10,00	19,17	0,38
	household (MSW)	82,63	87,63	82,63	87,63	85,13	1,67

Evaluation question III.d: eutrophication potential

stream question III.D: eutrophication potential

		assessed	
1	mineral	0,00	
2	wood	0,15	
3	bio-waste	5,00	
4	plastics	0,33	
5	paper and cardboard	0,13	
6	glass	0,05	
7	metals	0,32	
8	hazardous	0,16	average of all fractions except bio-waste
9	household (MSW)	1,67	one third of bio waste, because of the assessed composition of MSW

expressed in kg SO2 eq./t waste. Average between recycling rate 0% and recycling rate 100%
chapter 5.3

no data are available for the mixed categories municpal waste and hazardous waste. In order not to distort the MCA average values are assumed

	recycling rate 0%		recycling rate 100%		average	
	production	end of life	production	end of life		
mineral	0,00	0,10	0,00	0,10	0,05	0,00
wood	1,40	2,00	1,40	2,00	1,70	0,15
bio-waste	53,40	56,70	53,40	56,70	55,05	5,00
plastics	5,80	6,10	1,20	1,30	3,60	0,33
paper and cardboard	2,20	2,50	0,50	0,60	1,45	0,13
glass	0,60	0,70	0,50	0,50	0,58	0,05
metals	4,60	6,10	1,40	1,90	3,50	0,32
hazardous	2,43	2,92	0,83	1,07	1,81	0,16
household (MSW)	17,80	18,90	17,80	18,90	18,35	1,67

6.1.3.2 Outcome

The MCA on material and waste streams leads to following scores:

Table 54: Scores from MCA on material and waste flows

hazardous	2,3
metals	2,3
household (MSW)	1,8
bio-waste	1,8
plastics	1,6
mineral	1,2
wood	0,9
glass	0,5
paper and cardboard	0,4

6.1.4 MCA on policy strategies

6.1.4.1 Scoring the evaluation questions

Policy evaluation question I.a: technical effectiveness

	policy question I.a : technical effectiveness		
		value	motivation
1	awareness and education	1	no clear data on the effectiveness of awareness and education campaigns are available, and will depend heavily on the correspondance between the message/advice offered and what the consumer wants to know. No direct significant impact on waste prevention is expected. It is an instrument that supports other strategies.
2	ecodesign	5	a strategy that aims at waste prevention at the concept and design of a product/service; solving problems in this phase is usually technically more effective than more end-of-pipe solutions
3	extended producer responsibility	2	EPR is very effective in achieving recycling & recovery targets, but no data on the role of EPR in changes to product design are available. Of course, it is difficult to attribute a change in product design to a specific policy. EPR was meant as an instrument to create financial stimuli to producers to consider prevention as well as recycling, but in practice it has become an instrumetn to finance collection and recycling. Few or no prevention targets are connected to EPR instruments or agreements.
4	green public procurement	3	given the large expenditures of public authorities with real economic impact and its model role, GPP can have an important environmental impact.
5	labelling / certification	3	no clear data on the environmental effectiveness of labels is available. But labels are only an instrument for guiding consumers towards sustainable products, but they don't have a direct impact on waste prevention. Labelling is mainly an instrument supporting other strategies. Hovever, labels can play a role in qualitative prevention (e.g. the ecolabel, commercial labels on GMO or CFC free producnts etc…). Also certification systems like ISO1400x contain or are very well able to contain provisions on prevention.
6	marketing	2	marketing can be very effective in guiding consumers/purchasers towards sustainable products. Especially in-store marketing is very effective. However, marketing is only an instrument supporting other strategies and has no direct impact on waste prevention, although qualitative prevention can be a good topic for marketing purposes.
7	positive/negative financial stimuli	4	taxes and charges are effective when they are set at the appropriate level (not to high or low); subsidies are not as effective unless they are combined with standards/targets or taxes
8	prevention targets	2	if monitored and enforced, targets are 100% effective. However, there is no incentive to reduce waste beyond this target level. Moreover, setting the target is a difficult exercise. How much really can be reduced without excessive costs? How do you know this before you try it? How much will it cost? How do you take into account exogenous factors which alter the waste arisings? Who can be made responsible for meeting the target - the producer, the trader, the final consumer, etc.
9	product standards	3	if monitored and enforced, standards are 100% effective. However, there is no incentive to e.g. reduced the level of hazardous substances beyond the required level.
10	reuse	3	no direct effect on waste prevention, but postponement of the waste phase of a product, however reuse leads to indirect prevention of resource use: see paragraph 3.3.1
11	technology standards	3	if monitored and enforced, technology standards are 100% effective. They induce exit of the least performing firms operating in the market. However, this instrument can only reach to these levels of emission reduction where there are abatement technologies.
12	voluntary agreements	2	the effectiveness of voluntary agreements tends to be low, as few agreements have been found to contribute to environmental improvements significantly different from what would have happened anyway. However, the performance of voluntary agreements would be improved if there were a real threat of other instruments being used if targets are not met.

Policy evaluation question I.b: implementation costs

	policy question I.b : implementation costs		
		value	motivation
1	awareness and education	4	relatively cheap instrument in comparison with for instance regulatory or financial instruments
2	ecodesign	5	quantities and costs of materials and the required utilities for manufacture of a product are largely determined by the product, so especially cost savings can be obtained by ecodesign: negative cost
3	extended producer responsibility	3	EPR can be implemented in many different ways (individual or collective responsibility, physical or financial, etc.), resulting in very different implementation costs, varying from expensive to cheap
4	green public procurement	4	it cannot be generalised that green products always have higher purchase prices than non green product versions. In most product groups, the 'make' or brand of the product or other features have a much higher influence on the purchase price of a certain product than green criteria.
5	labelling / certification	3	costs for companies range from compliance & certification costs to costs for changing packaging; costs for public authorities include promotion and control costs
6	marketing	4	relatively cheap instrument in comparison with for instance regulatory or financial instruments
7	positive/negative financial stimuli	2	implementation costs are relatively high, because monitoring and enforcement costs are high. But for companies financial instruments (e.g. taxes or charges) are more cost-effective than regulatory instruments
8	prevention targets	1	implementation costs are relatively high, because monitoring and enforcement costs are high. Moreover, setting the target is a difficult exercise. How much really can be reduced without excessive costs? How do you know this before you try it? How much will it cost? How do you take into account exogenous factors which alter the waste arisings? Who can be made responsible for meeting the target - the producer, the trader, the final consumer, etc.
9	product standards	1	implementation costs are relatively high, because monitoring and enforcement costs are high
10	reuse	3	a measure to stimulate reuse is for example the financial support of reuse centres. The activities of a reuse centre also have a strong social dimension, and are therefore largely financed through social economy funding
11	technology standards	1	implementation costs are relatively high, because monitoring and enforcement costs are high
12	voluntary agreements	3	the costs of preparing, negotiating and operating voluntary agreements differ considerable from case to case, but in many cases - for instance if many different parties are directly involved, if the legal status of the agreement is ambigous, and/if detailed technical analyses of potential prevention options need to be carried out - the costs can be rather high. For simpler, perhaps less ambituous, agreements the costs can be lower.

Policy evaluation question II.a: political feasibility

	policy question II.a : political feasibility		
		value	motivation
1	awareness and education	5	widely applicable, easy to realise, high visibility and with relatively low implementation costs
2	ecodesign	5	a "hot topic" in many Member States, and an important element in the Commissions Integrated Product Policy
3	extended producer responsibility	4	EPR has been implemented in several waste related EU Directives; in some countries it is also applied to other waste streams such as old and expired medication, used vegetable/animal oil and fat, fotochemicals, etc.
4	green public procurement	2	large differences between Member States, but so far only a limited number of countries have a national strategy /action plan on GPP (most MS are in the process of drafting one). Drops in popularity when public budgets are under stress
5	labelling / certification	3	the EU Ecolabel dates from 1992 (Regulation 880/92/EEC), and new product categories are added on a continuous basis. But already so many labelling and certificate schemes exist that there is some reluctance to introduce yet another scheme.
6	marketing	2	few examples of authorities using marketing techniques to stimulate sustainable consumption are available, probably because little experience within the authorities is available
7	positive/negative financial stimuli	3	commonly used because of their cost effectiveness. In March 2007, the European Commission launched a Green Paper on advancing the use. of market-based instruments across the Member States to support environment and energy policies. However, political will for implementation of measures that have an impact on public budget or that require the imposition of new taxes/levies is low, especially in difficult economic times.
8	prevention targets	2	the definition of prevention target has been included in the new Waste Framework Directive, but with many difficulties and with a long transition period. No final decisions are taken until now due to lacking political support.
9	product standards	4	standards are one of the most oldest and most commonly used instruments
10	reuse	4	reuse centres are usually supported by authorities as having a social benefit next to an ecological benefit; but waste prevention has a higher priority than reuse
11	technology standards	4	standards are one of the most oldest and most commonly used instruments
12	voluntary agreements	4	the use of voluntary agreements is still increasing, although not specifically regarding waste prevention. A voluntary agreement is a good instrument to introduce measures and to test them. However, permanent solutions require legally binding agreements.

Policy evaluation question II.b: administrative feasibility / burden & transaction costs

	policy question II.b : administrative feasibility / burden & transaction cost		
		value	motivation
1	awareness and education	4,5	low administrative burden
2	ecodesign	5	no administrative burden
3	extended producer responsibility	3	administrative burden depends on the design of the system (individual or collective responsibility, physical or financial, etc.)
4	green public procurement	2	for companies relatively high administrative burden for demonstrating compliance with tender criteria
5	labelling / certification	3	companies need to document the compliance of their products
6	marketing	4,5	no supplementary administrative burden for industry
7	positive/negative financial stimuli	2	relatively high administrative burden, because of monitoring, reporting and enforcement requirements
8	prevention targets	2	relatively high administrative burden, because of monitoring, reporting and enforcement requirements
9	product standards	2	relatively high administrative burden, because of monitoring, reporting and enforcement requirements
10	reuse	4	depending of the measure taken; for reuse centre the burden is limited to the reporting of repaired/sold second hand products to the competent authority
11	technology standards	2	relatively high administrative burden, because of monitoring, reporting and enforcement requirements
12	voluntary agreements	3	the administrative burden and transaction costs can be high if many parties are involved, and if a sanctioning schedule is in place if targets are not met

Policy evaluation question II.c: legally binding / enforceable

	policy question II.c : legally binding / enforceable		
		value	motivation
1	awareness and education	1	a communication instrument that intends to change behaviour, but which holds no enforceable or legally binding targets or rules. So, the individual consumer, purchaser or company can decide not to follow the 'advice' given.
2	ecodesign	3	ecodesign can be made mandatory (e.g. EuP directive). The Essential Requirements are an example of mandatory ecodesign with regard to waste prevention. In practice, however, they are hardly enforceable (see Survey on compliance with the Essential Requirements in the Member States (European Commission, 2009)
3	extended producer responsibility	3	the requirements of and EPR scheme are legally binding and can be enforced, but the real objective of an EPR scheme can not be enforced. EPR requirements want to encourage manufacturers to design environmentally-friendly products by holding producers liable for the costs of managing their products at the end of their life cycle. In practice, however, producers pay for collection, recycling and safe disposal of the waste stream, but pay little attention to ecodesign.
4	green public procurement	3	GPP could be made mandatory, but in practice it is mostly voluntarily
5	labelling / certification	2	mandatory labels do exist (e.g. energy label), but they only offer information. The individual consumer or purchaser can decide not to follow the 'advice' given. Most labels are voluntarily schemes. No mandatory labels exist regarding waste or waste prevention.
6	marketing	1	a communication instrument that intends to change behaviour, but which holds no enforceable or legally binding targets or rules. So, the individual consumer, purchaser or company can decide not to follow the 'advice' given.
7	positive/negative financial stimuli	3	taxes are legally binding and can be enforced; the objective of financial stimuli (change in consumer or company behaviour) however, can not be enforced. Companies and consumers can decide not to use a subsidy, or to pay a tax instead of decreasing their emissions.
8	prevention targets	5	prevention targets forces authorities to decrease the generated waste in their country, region or municipality
9	product standards	5	a product standards forces a company to respect the requiren physical characterics of the product
10	reuse	3	in some Member States mandatory reuse targets have been implemented, e.g. a target amount (kg/habitant) of second-hand products that needs to be prepared for reuse and sold, but there is no common reuse target at EU level
11	technology standards	5	a technology standard forces a company to use a particular abatement technology
12	voluntary	2	voluntary schemes, but sometimes enforcable through private law, contractual provisions

Policy evaluation question II.d: field experience

	policy question II.d : field experience		
		value	motivation
1	awareness and education	5	long-term experience within a broad range of environmental fields
2	ecodesign	3	long-term experience within the industry, e.g. towards decreased use of raw materials; within public authorities "ecodesign" has become more recently a "hot topic". The first "ecodesign directive" (EuP Directive 2005/32/EC) came into force in 2005, but only aimed the energy efficiency of products.
3	extended producer responsibility	4	EPR has been implemented in several Member States even before the implementation of the Packaging Directive (that first introduced EPR for packaging waste); it is however implemented for only a limited number of waste streams
4	green public procurement	3	large differences exist between Member States, e.g. the 'Green-7' have significant more tenders in which environmental criteria are included. In 2005 the Commission launched a handbook on GPP. But regarding waste, most environmental criteria only refer to recyclability of (parts of the) product and to packaging prevention.
5	labelling / certification	3	long-term experience with labels and certification in a broad range of environmental fields, but only limited experience with waste prevention labelling. Ecolabels like the EU Ecolabel contain waste criteria, but they are limited to recyclability and to packaging prevention.
6	marketing	5	long-term experience within the industry
7	positive/negative financial stimuli	5	long-term experience within a broad range of environmental fields
8	prevention targets	1	recycling targets or targets regarding the reduction of household waste exists, but no prevention targets
9	product standards	5	long-term experience within a broad range of environmental fields
10	reuse	5	long-term experience with second-hand stores and reuse centres
11	technology standards	5	long-term experience within a broad range of environmental fields
12	voluntary	1	only a limited number of voluntary agreements concerning waste prevention

Policy evaluation question III.a: phase in life cycle

	Policy question III.A: phase in life cycle - answers valid for all material streams		
	SCORES - 1: waste & post-waste; 2: distribution; 3: production; 4: raw materials; 5: ecodesign & consumption (= preventing waste by not bying it)		
	When an instrument interacts at an early stage in the life cycle, its effects will work throughout the subsequent stages: the earlier, the better.		
		value	motivation
1	awareness and education	5	applicable for all phases, but in practice most common in stimulating consumers towards sustainable consumption
2	ecodesign	5	waste prevention at the stage of the design of the product
3	extended producer responsibility	1	in theory aimed at stimulation ecodesign, but in practice limited to industry paying for the recycling of their products
4	green public procurement	5	stimulating sustainable consumption
5	labelling / certification	5	stimulating sustainable distribution and consumption
6	marketing	5	stimulating sustainable consumption
7	positive/negative financial stimuli	3	applicable for all phases, but in practice most found in a.o. LIFE-subsidies or discount coupons for sustainable products
8	prevention targets	3	instruments that aim for waste prevention early at the life cycle of a product are more efficient in achieving prevention targets
9	product standards	5	requirements on the design of the product (e.g. Essential Requirements on packaging)
10	reuse	4	postponement of the waste phase of the product
11	technology standards	3	BAT in production phase, resulting in less industrial waste and reduction of raw materials use
12	voluntary agreements	2	applicable for all phases, but in practice most common in distribution (e.g. conventions between government & distribution on availability on sustainable products, consumer agreements,…)

Policy evaluation question IV.a: fairness - polluter pays principle

	policy question IV.a : fairness - polluter pays principle		
		value	motivation
1	awareness and education	1	implementation costs are largely borne by public authorities, although some campaigns are borne by the industry (e.g. sorting and collection of recyclable waste streams)
2	ecodesign	5	implementation costs are largely borne by the industry, responsible for the use of polluting elements
3	extended producer responsibility	3	implementation costs and administrative burden are largely borne by the industry, responsible for the use of polluting elements although some costs still may be transferred to the distribution sector (only partly responsible) or even the authorities (e.g. free or cheap use of civic amentiy sites for reverse logistics)
4	green public procurement	1	implementation costs and administrative burden are largely borne by public authorities; companies have some costs and administrative burden to demonstrate compliance with the tendering criteria
5	labelling / certification	3	implementation costs are partly borne by public authorities (definition of criteria, compliance control, etc.) and partly by the responsible industry (fees for use of the label, certification, costs for demonstrating compliance, etc.)
6	marketing	3	both companies and public authorities can start marketing campaigns to stimulate sustainable consumption
7	positive/negative financial stimuli	3	In case of positive financial stimuli public authorities bear the costs, in case of negative financial stimuli responsible companies or consumers bear the costs
8	prevention targets	3	prevention targets are binding for public authorities, but they will use other strategies to move the industry and consumers towards waste prevention, usually respecting the polluter pays principle
9	product standards	4	implementation costs are largely borne by the responsible industry, but public authorities also bear costs for enforcement of the standards
10	reuse	2	implementation costs are largely borne by public authorities: reuse centres are usually subsidized; consumers pay a small price for the reused product
11	technology standards	4	implementation costs are largely borne by the responsible industry, but public authorities also bear costs for enforcement of the standards
12	voluntary agreements	4	implementation costs are largely borne by the responsible industry, althoug public authorities can be one of the actors and/or provide financial support

Policy evaluation question IV.b: technological innovation

	policy question IV.b : technological innovation		
	Technological innovation includes creation of new markets		
		value	motivation
1	awareness and education	3	no direct impact on technology; but the creation of markets (by awareness, GPP and marketing) is on of the most important steps of technology development
2	ecodesign	5	= technological innovation
3	extended producer responsibility	2	in theory aimed at stimulating ecodesign, but in practice limited to industry paying for the recycling of their products. No data on the role of EPR in changes to product design are available. Of course, it is difficult to attribute a change in product design to a specific policy.
4	green public procurement	4	GPP can stimulate cleaner production of greener products, but in practice most tendering criteria focus on hazardousness of products/services and energy efficiency/carbon footprint. Green public procurement can however generate the initial market at a scale needed for the launch or breakthrough of innovative solutions, or to make innovation profitable.
5	labelling / certification	2	no direct impact on technology; communication instrument directed towards consumers/purchasers; although in theory producers might green their production process or products to obtain an ecolabel
6	marketing	3	no direct impact on technology; but the creation of markets (by awareness, GPP and marketing) is on of the most important steps of technology development
7	positive/negative financial stimuli	4	pollutors that decrease their emissions through new technology are awarded by lower taxes, subsidies or other. The choice of the technology is left to to the company. But the financial stimulus must be high enough and should be directly related to the pollution.
8	prevention targets	1	no direct impact on technology, because they bind authorities and not companies or households
9	product standards	3	less impact than financial instruments, because the polluter is not 'rewarded' with e.g. lower tax or subsidies and because the "potential space" for innovation is constrained, but standards provide clear signals as to what physical properties of the product are unwanted, which in turn could be targeted by inventors
10	reuse	3	no direct impact on technology, as this strategy is about postponing the waste phase of a product. However, when reuse becomes economically important it may stimulate "design for reuse".
11	technology standards	3	less impact than market-based instruments, because the polluter is not 'rewarded' with e.g. lower tax or subsidies and because the "potential space" for innovation is constrained, but standards provide clear signals as to what physical properties of the production process are unwanted, which in turn could be targeted by inventors
12	voluntary agreements	2	the incentive to develop new technologies is weak, because of the small benefit of reducing emission beyond what is stipulated in a standard or agreement. Voluntary approaches are more likely to contribute to diffusion of new technologies.

6.1.4.2 Outcome

Table 55: Scores from MCA on policy strategies

	score
ecodesign	4,39
product standards	3,04
marketing	2,94
reuse	2,94
labelling / certification	2,93
positive and negative financial stimuli	2,92
technology standards	2,74
green public procurement	2,72
awareness, education and other information	2,68
voluntary agreements	2,37
extended producer responsibility	2,22
prevention targets	1,87

6.1.4.3 Literature

The assessment of the policy strategies was based on the following literature sources:

Bouwer M, de Jong K, Jonk M, Berman T, Bersani R, Lusser H, Nissinen A, Parikka K and Szuppinger P, 2005. Green Public Procurement in Europe 2005 - Status overview. Virage Milieu & Management bv, Korte Spaarne 31, 2011 AJ Haarlem, the Netherlands, pp 107, http://europa.eu.int/comm/environment/gpp/media.htm#state

CTPA – OECD Centre for Tax Policy and Administration (2007) Impacts of environmental policy instruments on technological change, OECD, pp 34

European Environment Agency (1996) Environmental taxes — implementation and environmental effectiveness, EEA, Copenhagen, pp 65

European Environment Agency (2006) Using the market for cost-effective environmental policy - Market-based instruments in Europe, EEA No 1/2006, Copenhagen, pp 46

Lust A, Laureysens I, Van Acoleyen M (2009) Survey on compliance with the Essential Requirements in the Member States, European Commission, Brussels, pp. 139

Hogg D, Gibbs A, Ballinger A, Coulthurst A, Elliott T, Fletcher D, Russell S, Sherrington C, Taylor S, Wilson D, et al. (2009) International review of waste management policy, Eunomia Consulting for Department of the Environment, Heritage and Local Government, Ireland, pp 78 + annexes

OECD (2003) Voluntary approaches for environmental policy. Effectiveness, efficiency and usage in policy mix, OECD, France, pp 143

OVAM (2008) Analysis of innovative environmental policy instruments towards the realisation of environmentally responsible production and consumption, OVAM (Flemish Waste Agency), Mechelen (Belgium), pp 94 + attachments

PPC – OECD Working group on Pollution Prevention and Control (1998) Extended and Shared Producer Responsibility - Phase 2 Framework report, OECD, pp. 90

Rousseau S, Proost S (2002) The cost effectiveness of environmental policy instruments in the presence of imperfect compliance - Katholieke Universiteit Leuven Working Paper Series n° 2002-04, Leuven (Belgium), pp 24

Rüdenauer I, Dross M, Eberle U, Gensch C, Graulich K, Hünecke K, Koch Y, Möller M, Quack D, Seebach D, Zimmer W, et al (2007) Costs and Benefits of Green Public Procurement in Europe - General recommendations, Öko-Institut, Freiburg, pp 5

Schmidt-Pleschka R, Dickhut H (2005) Guiding systems for sustainable products in the retail industry. Sales-enhancing consumer communication at the Point of Sale, Die Verbraucher Initiative, Berlin, pp 14

United Nations Environment Programme (2005) The Trade and Environmental Effects of Ecolabels: Assessment and Response, UNEP, pp 44

United Nations Environment Programme (2007) Assessment of Policy Instruments for Reducing Greenhouse Gas Emissions from Buildings, UNEP, pp 83

WGWPR (2006) EPR Policies and Product Design: Economic Theory and Selected Case Studies, OECD, pp. 60.

6.1.5 Combining material streams with policy strategies

The final scores of paragraphs 6.1.3 and 6.1.4 can be counted together in a matrix of materials and strategies.

Table 56: Matrix of combined MCA on materials and strategies

		strategies											
		awareness, education and other info	ecodesign	EPR	GPP	labelling / certification	marketing	positive/neg. financial stimuli	prevention targets	product standards	reuse	technology standards	voluntary agreements
material flows		1	2	3	4	5	6	7	8	9	10	11	12
mineral	1	3,883747	5,59	3,42	3,92	4,13	4,14	4,12	3,07	4,24	4,14	3,94	3,57
wood	2	3,532068	5,24	3,07	3,57	3,78	3,79	3,77	2,72	3,89	3,79	3,59	3,22
bio-waste	3	4,44609	6,15	3,98	4,49	4,69	4,7	4,68	3,64	4,8	4,7	4,5	4,14
plastics	4	4,313042	6,02	3,85	4,35	4,56	4,57	4,55	3,5	4,67	4,57	4,37	4
paper and cardboard	5	3,094863	4,8	2,63	3,13	3,34	3,35	3,33	**2,28**	3,45	3,35	3,15	2,78
glass	6	3,171393	4,88	2,71	3,21	3,42	3,43	3,41	2,36	3,53	3,43	3,23	2,86
metals	7	4,994891	6,7	4,53	5,03	5,24	5,25	5,23	4,18	5,35	5,25	5,05	4,68
hazardous	8	5,011793	**6,72**	4,55	5,05	5,26	5,27	5,25	4,2	5,37	5,27	5,07	4,7
household (MSW)	9	4,479919	6,18	4,01	4,52	4,72	4,73	4,71	3,67	4,83	4,73	4,53	4,17

Because not every strategy can be combined with every material or waste stream, an assessment is made on which combinations fit. The combinations are divided in three classes:

0: does not fit at all

1: show a rather weak fit

2: shows a strong fit

Table 57: Matrix on fit between material and strategy

		strategies											
		awareness, edu	ecodesign	extended produ	green public pro	labelling / certifi	marketing	positive and neg	prevention targe	product standar	reuse	technology stan	voluntary agreei
material flows		1	2	3	4	5	6	7	8	9	10	11	12
mineral	1	2	1	0	2	1	2	2	2	2	2	2	2
wood	2	2	1	0	2	2	2	2	1	2	1	2	2
bio-waste	3	2	0	0	2	1	2	2	1	2	0	2	2
plastics	4	2	2	2	2	2	2	2	2	2	0	2	2
paper and cardboard	5	2	1	2	2	2	2	2	2	2	0	1	2
glass	6	2	1	2	2	2	2	2	2	2	0	1	2
metals	7	2	1	2	2	2	2	2	2	2	0	2	2
hazardous	8	2	2	1	2	1	1	2	1	2	0	2	2
household (MSW)	9	2	0	0	0	0	0	2	1	0	0	0	2

Finally, by multiplying the data from Table 56 with the data from Table 57, the matrix of high potential areas for prevention can be calculated.

Table 58: Matrix of high potential areas for prevention

		strategies											
		awareness & education	ecodesign	EPR	GPP	labelling / certification	marketing	positive/neg. financial stimuli	prevention targets	product standards	reuse	technology standards	voluntary agreements
material flows		1	2	3	4	5	6	7	8	9	10	11	12
mineral	1	7,77	5,59		7,85	4,13	8,28	8,24	6,15	8,48	8,28	7,88	7,15
wood	2	7,06	5,24		7,14	7,55	7,57	7,53	2,72	7,77	3,79	7,17	6,44
bio-waste	3	8,89			8,97	4,69	9,4	9,36	3,64	9,6		9	8,27
plastics	4	8,63	12	7,7	8,71	9,12	9,14	9,1	7,01	9,34		8,74	8,01
paper and cardboard	5	6,19	4,8	5,26	6,27	6,68	6,7	6,66	4,57	6,9		3,15	5,57
glass	6	6,34	4,88	5,41	6,42	6,83	6,85	6,81	4,72	7,05		3,23	5,72
metals	7	9,99	6,7	9,06	10,1	10,5	10,5	10,5	8,37	10,7		10,1	9,37
hazardous	8	10	**13,4**	4,55	10,1	5,26	5,27	10,5	4,2	10,7		10,1	9,4
household (MSW)	9	8,96						9,43	3,67				8,34

6.1.6 Result

Table 59 : Top 20 of high potential areas for waste prevention

ecodesign	hazardous	13,4
ecodesign	plastics	12,0
product standards	hazardous	10,7
product standards	metals	10,7
marketing	metals	10,5
positive/neg. financial stimuli	hazardous	10,5
labelling / certification	metals	10,5
positive/neg. financial stimuli	metals	10,5
technology standards	hazardous	10,1
GPP	hazardous	10,1
technology standards	metals	10,1
GPP	metals	10,1
awareness & education	hazardous	10,0
awareness & education	metals	10,0
product standards	bio-waste	9,6
positive/neg. financial stimuli	household (MSW)	9,4
voluntary agreements	hazardous	9,4
marketing	bio-waste	9,4
voluntary agreements	metals	9,4
positive/neg. financial stimuli	bio-waste	9,4

Following the results of the MCA, hazardous and metal wastes have the highest environmental impact. Although the amount of mineral waste is 15 to 40 times larger than other waste streams, its low hazardousness and environmental impact make it a waste stream that should not be prioritised if budget for waste prevention measures is limited.

Ecodesign and product standards are the preferred strategies or instruments according to the MCA. Ecodesign scores very high (4,39 on 5), because it has the maximum score with respect to efficiency, prevention at source (cfr. phase in the life cycle), fairness (cfr. Polluter pays principle) and technological innovation.

The combination of target waste streams and strategies results in the following top 5:

1. Ecodesign reduce hazardous waste
2. Ecodesign to reduce plastic waste
3. Product standards reduce hazardous waste
4. Product standards reduce metal waste
5. Marketing techniques to reduce metal waste

Plastic waste appears in this top 5 because it is easier to prevent plastic or hazardous waste (i.e. by choosing alternative material) than it is to prevent metal waste.

6.2 Key examples

In order to illustrate the waste prevention strategies evaluated above the following table lists waste prevention initiatives from EU-Member-States as key examples. It was envisaged to find at least one key example for each waste prevention strategy. However, most waste prevention initiatives bear characteristics of more than one waste prevention strategy or are a mix of different strategies. Therefore the shown key examples frequently could have been allocated also to a different strategy.

Other strategies / waste streams are not covered by an example, like prevention of non-hazardous metal waste. (Qualitative) waste prevention with metals up to now was done only for limiting hazardous metals. That the use of some metals should be reduced because they are too precious to be wasted is an idea which came up only in recent years. Similarly, public administration only recently realized that marketing might be an important instrument, e.g. for the establishment of reuse-networks. While usually industries market their eco-efficient products (although seldom under the tag “waste prevention”), the marketing of waste prevention normally is denominated as “awareness” of “information” campaign.

Table 60 : Key examples for the waste prevention strategies from different EU-Member States

Strategy	**Key example**	**Country**	**Targeted waste stream**	**Literature/Link**
Awareness, education and other information	**Sensitization project for schools** In a folder the mascot BAS gives pupils and their parents 12 hints on how to buy environment-friendly materials. Teachers receive an educational file with information and hints on how to prevent waste, shopkeepers promote environment-friendly school materials with BAS posters. In 2003 150,000 folders were distributed in Flemish schools.	BE	MSW	www.ovam.be, personal communication Philippe Van De Velde, OVAM, 2005
Awareness, education and other information	**PIUS – Internet forum for cleaner production of SMEs** The core of the PIUS Internet forum is the 'information pool' where compact know-how on production integrated environmental protection is available in the form of project reports, industry guides, action catalogues, practical information, software, conference literature and reading lists for enterprises. At present, approximately 400 documents with a total of around 3000 pages are to be found in the already comprehensive information pool, which is constantly being expanded. Some examples from the wide range of subjects include the following: a) industries: printing, paint finishing plants, galvanic processing, car repair trade, surface cleaning, etc. b) materials: solvents, cooling lubricants, photo chemicals, c) fields: environmental management and environmental software. In addition, the PIUS Internet forum provides interactive elements, for example, an expert forum for the exchange of specialist information, a	GE	Industrial Hazardous	http://www.pius-info.de/en/index.html

Strategy	Key example	Country	Targeted waste stream	Literature/Link
	comprehensive online order service and a calendar with current seminars and conferences taking place nationwide. The link to the materials database Oekopro provides users with information on chemicals and materials in their branch of production.			
Awareness, education and other information	**Stop Pub (No Junk Mail)** French households receive an average of 15kg of unaddressed mail each year, accounting for 5% of household waste. The French administration launched a campaign, “Réduisons vite nos déchets, ça deborde”, drawing attention to the urgent, ‘overflowing’ reality of the waste problem. A key feature of the campaign is Operation ‘Stop Pub’, in which a post box sticker was produced expressing the resident’s will not to receive unaddressed mail. The sticker is available from local town councils, department stores and community and environmental NGOs. They can also be downloaded on several government websites. The initiative aims to directly reduce junk mail in household waste, to stimulate public engagement in household waste prevention, and to discourage the market for unaddressed mailings.	FR	Paper	www.ecologie.gouv.fr/stop-pub.html
Awareness, education and other information	**SuperDrecksKescht® information programme in Luxembourg** SuperDrecksKescht® is an initiative which informs citizens, companies and public institutions by means of an information center and an internet site regarding the possibly of preventing waste and alternative products. The SuperDrecksKescht® fir Biirger is an action by the Ministry for the environment together with the communes. The objective is to prevent waste from households. The SuperDrecksKescht® fir Betriber is an action by the Ministry for the environment together with the Chambre des Métiers. It offers information and advisory services to companies regarding waste management issues and supports them in an environment correct operation.	LU	MSW, industrial waste	http://www.sdk.lu/ Personal communicaton Thomas Hoffmann-Resch, Zone Industrielle Piret, 2005
Awareness, education and other information	**Menu Dose Certa** The Menu Dose Certa project aims to reduce food waste by 48.5 kilos per year per restaurant client by 2011 and attempts to change attitudes and behaviours by raising awareness on the problem of food waste. The goal is to support restaurants in creating menus that generate notably less food waste. The project is a partnership between LIPOR, the Association of Portuguese Nutritionists, the local authorities of Espinho and local restaurants. The initiative was kicked off at the Cristal restaurant in Espinho, generating significant media attention at regional and national level. The project will continue to be expanded with a competition among participating restaurants to produce the best recipe for a Right Serving Menu, in terms of serving size and	PT	Food waste from restaurants	www.lipor.pt

Strategy	Key example	Country	Targeted waste stream	Literature/Link
	nutritional value. Winning menus will be collected in a recipe book promoted in local media.			
Awareness, education and other information	**Municipal waste management – Handbook** During the autumn of 2010 a handbook on waste prevention is presented.. The target group is municipalities. The handbook contains guidance and practical advice on how municipalities should/can work with waste prevention. It also includes "good examples" from Sweden and other countries.	SW	MSW	Personal communication Cecilia Mattsson, Naturvardsverket, 2010
Awareness, education and other information	**Love Food Hate Waste** According to a WRAP report one third of the food bought in the UK is wasted. Since May 2008, WRAP's consumer-facing 'Love Food Hate Waste' campaign has encouraged behavioural change. WRAP works with the UK grocery sector, food industry, Government and organisations such as the Food Standards Agency, to develop practical solutions and improved communications to make it easier for consumers to get the most from the food they buy, and to waste less of it. The practical advice provided includes: - A meal planner and a portion calculator - Tips for good storage of food - Recipes for cooking with leftovers.	UK	food	www.lovefoodhatewaste.com
Ecodesign	**House of the Future** The impulse programme "Nachhaltig Wirtschaften" (Sustainable Housekeeping) finances pilot and demonstration projects on the innovative utilisation of renewables (such as straw or wood) and eco-efficient construction materials for low energy consuming buildings. In the period 2007 to 2009 40 such projects were supported.	A	C&D, biomass	BMVIT (2009)
Ecodesign	**Factor10, Flemish information point for ecodesign** Factor 10 provides information through a web site, helpdesk and digital newsletter, workshops and seminars. The core medium is the web site, which gives all information about events, links, tools and ecodesign examples. The helpdesk is available for people who weren't able to find the answer to their questions elsewhere. The newsletter provides the subscribers the latest national and international news on ecodesign.	BE	Industrial, Commercial, Household	http://www.factor10.be/, personal communication Wouter Ulburghs, Factor 10 – OVAM, 2005
Ecodesign	**Ecolizer 2.0** The Ecolizer is OVAM's unique eco-design tool. It is intended to be used by designers and companies that are seeking to estimate the environmental impact of the products they design. OVAM has developed this instrument to make eco-design more accessible for designers. There are many other methods and instruments that help implement eco-design but they are not as user-	BE	All waste types	www.ovam.be.

Strategy	Key example	Country	Targeted waste stream	Literature/Link
	friendly and often involve advanced but complex methods that demand a great deal of expertise from the user. The flow of this academic information to the world of design is, however, limited and even where it is available, it is not often used. The Ecolizer 2.0 uses the new ReCiPe method. This indicator (expressed in eco-points) captures the environmental impact of both materials and processes in a single figure. The indicators are a simple but reliable source of information for making decisions and integrating eco-design into the design process in a user-friendly way and make it easy for a designer to make an environmental assessment for one or various product proposals. The Ecolizer allows for a quick and simple environmental assessment of the various materials and production processes used.			
Ecodesign	**Eco-Emballages Packaging Advisory** Members of Eco-Emballages are supported in their waste minimisation efforts by training and consulting services on efficient packaging design and by help assessing and redesigning existing packaging strategies. Several services are offered free of charge to Eco-Emballages members. These include: - Intensive one-day eco-design training sessions for engineers and designers with a focus on packaging minimisation. Courses use simplified life cycle analysis methodology. - Packaging audits for SMEs, conducted in two days, which identify ways to optimise packaging use and minimise waste. These audits are now being expanded to larger businesses. - Partnerships with students at ESIEC, a French engineering school specialised in packaging, wherein the student leads a company project on packaging waste prevention.	FR	Packaging waste	www.ecoemballages.fr
Ecodesign	**Ecodesign of e-commerce packaging** An Italian consortium for the recovery and recycling of cellulose-based Packaging studies the impact of e-commerce shipping packaging and logistics in order to minimize the packaging of shipment sent directly to consumers.	IT	Paper	Personal communication Eliana Farotto, Comieco, 2005
Extended producer responsibility	**Producer responsibility for packaging waste** Duales System Deutschland AG (DSD) organises the collection, sorting and recycling of sales packaging materials. 537 waste management companies contracted by DSD are responsible for the collection, sorting and recycling activities. The system is financed by means of licence fees. The producers of the goods pay a license fee according to the weight/volume of the packaging used for the products. Thereby they obtain the right to mark their products with 'the Green Dot' symbol. The main driver of the system is the 'The Packaging Ordinance', which states that producers and importers are obliged to	GE	Product packaging	http://www.gruener-punkt.de/

Strategy	Key example	Country	Targeted waste stream	Literature/Link
	collect and recycle the packaging waste from their products. By joining DSD the producers and importers are released from individual take-back obligations. The license fee for joining the system not only finances DSD but also encourages the companies to minimise their use of packaging material. DSD only takes care of sales packaging, but the Packaging Ordinance is also aimed at transport packaging. The handling of transport packaging is organised by other companies.			
Extended producer responsibility	**Take back obligations for batteries and waste from electric and electronic equipment (WEEE)** In Austria a voluntary take back system for batteries was established already in 1993 on the basis of a voluntary agreement with the retail sector. By now directives 2006/66/EC and 2002/96/EC require from EU Members States the installation of systems which take batteries and WEEE back free of charge. Essentially the take back system is put on 2 columns: 1. The consumer may give back the old commodity at any point where he buys a new one 2. The consumer may bring the batteries and WEEEs to communal waste collection centers.	EU, A	Hazardous waste	
Green public procurement	**Ökokauf Wien (EcoBuy Vienna)** Criteria lists for the public purchasing of 23 product groups (ranching from lighting to nanotechnologies) have been developed and are used by the City of Vienna. Among the criteria are such targeted at waste prevention.	A	Most waste types, Paper waste	http://www.wien.gv.at/umweltschutz/oekokauf/
Green public procurement	**Ferrara Green Public Purchasing** In 1995 the Municipality of Ferrara started to set up a system of green public procurement and has improved this system continuously ever since. Some core activities within this framework are: - Biological food in public schools: the project "Food-Man-Environment" has involved, on the one side, personnel from the public education service and from the purchase service and, on the other side, the parents of children attending public schools (from nursery schools to high schools); - Detergents and cleansing products in public offices: i.e. recycled hygienic paper and towels, certified chemical products, recycled/recyclable packaging for chemicals; - Electric bikes for municipality staff; - School transportation by low impact school busses with antipollution devices (EURO3); - Ecological paper for printers and photocopy machines in public offices; - Purchasing of all photocopy machines for public	IT	MSW, WEEE	http://www.comune.fe.it/, personal communication Valeria Nardo, Purchasing Services, Municipality of Ferrara, 2005

Strategy	Key example	Country	Targeted waste stream	Literature/Link
	offices, with Energy Star and Blue Angel labels.			
Labelling / certification	**OI3-Index for the labelling ecological buildings** The OI3-Index is an evaluation system which shows if a certain building meets ecological and sustainability criteria. It is based on the principles of Lifecycle assessment. Among the criteria introduced in recent years are: - Environmental impact during preparation of materials, construction and use, - life time of construction materials - utilisation period of construction parts - environmental impact in the waste phase and recyclability. This system may provide the basis for the development of a building material information system (Building Pass) which accompanies the building during its whole life.	A	C&D	Zipfel (2008), IBO (2009)
Labelling / certification	**Eco labelling “Blauer Engel**” Environmentally friendly products can be awarded an eco-label (Blauer Engel) if they meet certain criteria (e.g. use of recycled materials, low toxicity). The label informs consumers concerning product attributes. Examples are: remoulded tyres, products made of recycled paper, organic solvent-free paint, etc. The labels provide practical guidance to consumers and considerably help them in their selection and their decisions on what to buy.	GE	All types	http://www.blauer-engel.de/
Labelling / certification	**Ecological Label of the Province of Bolzano** Food and general stores which comply with a number of environmental standards in offering their products, in informing the public and in training their staff, receive the “Ecological label”. Food and general stores joining this initiative have to comply with a number of standards which can be divided into: 1) Ecological measures: such as sale of cloth shopping bags at purchase price, offering, in particular, drinks in returnable empties and loose goods; 2) Biological products, 3) regional products, 4) fair trade products.	IT	MSW, retail waste	Personal communication Heidi Thaler, Province of Bolzano, 2005
Labelling / certification	**The “Clever Akafen” – or “clever shopping” - eco-label** “Clever Akafen” is a multi-stakeholder initiative to promote products that have a low ecological impact. Paints, rechargeable batteries and accessories, low energy lamps and LED (Light-Emitting Diode) lamps that meet the selection criteria (e.g. longevity, small pollutant contents) area awarded the label. Detergents will also be included in the scheme in the future.	LU	Hazardous waste, WEEE	www.sdk.lu
Marketing	**Repair guides and repair centers** The municipalities of the largest Austrian towns (Vienna, Linz, Graz) and some regional administrations have developed a	A	WEEE Hazardous waste	Eisenriegler S. (2010)

Strategy	Key example	Country	Targeted waste stream	Literature/Link
	repair/lending/second hand guide, as leaflet and/or internet based with search functions, containing repair tips and the addresses of repair/lending/second hand companies. A special initiative of the Vienna municipality is the R.U.S.Z. (Reparatur und Service Zentrum – Repair and Service Center), where jobless persons are trained in repairing skills, repair goods at affordable prices and disassemble electronic equipment so that hazardous and non-hazardous waste are separated. Mostly repaired are electronic and electrical devices of households.			
Marketing	**Internet exchange of excavated soil and construction waste (Boden-, Bauschutt- und Bauteilbörse BBB)** The web-based marketplace BBB is an electronic platform for information exchange concerning excavated soil, demolition and construction waste. Supplies and demands for used building and construction materials and soil can be entered, searched or deleted online. BBB can be used by those offering construction materials or intending to buy such materials. It provides information concerning the amount and quality of excavated soil, demolition and construction waste. In addition, waste generation related data and potential use are available. The use of BBB is free and accessible to every interested person.	GE	C&D	http://www.alois-info.de/, personal communication Katharina Wolff, Landesumweltamt Nordrhein-Westfalen, 2005
Marketing	**Biodegradable shopping bags in the Municipality of Arzignano (Vicenza)** The regional administration informs and seeks to get voluntary agreements with retail organizations to use and distribute shopping bags made from biodegradable renewables. The first step was to increase public awareness on waste problem with informative campaigns. In the second step public administration proposed to retailers an agreement for commercialisation of biodegradable shopping bags. In the third step public administration published on its newspaper the shops which had agreed to use biodegradable bags.	IT	Plastic	http://www.comune.arzignano.vi.it/jsparzignano/index.jsp, personal communication Danilo Guarti, Municipality of Arzignano, 2005
Marketing	**Sustainable Clothing Action Plan** The UK administration together with nearly 300 stakeholders has developed and agreed an action plan containing some 80 activities (to be implemented in the period2008-2012) to reduce the environmental impact of clothes along the life cycle and to market eco-efficient clothes. These comprise activities in following areas: 1. Improving environmental performance across the supply chain - by sustainable design (e.g. by developing “green factories”) - by reducing the impacts of fibres and fabrics - by maximising reuse, recycling and end of life management	UK	Textiles	DEFRA (2009), www.defra.gov.uk

Strategy	Key example	Country	Targeted waste stream	Literature/Link
	- by reducing the impact of clothes cleaning 2. Consumption trends and behaviour 3. Awareness, media, education and networks (e.g. produce an online resource for "Good Practise" in textile printing and decoration) 4. Creating market drivers for sustainable clothing (e.g. by a sustainable procurement public sector clothing demonstration project) 5. Development and implementation of instruments for improving traceability along the supply chain (ethics, trade and environment) (e.g. by introducing new Fairtrade lines).			
Positive and negative financial stimuli	**Fabrik der Zukunft (Industrial Plant of the Future)** In this initiative project developers can apply for financing research and development of technologies targeted at sustainable production and waste prevention. In one year alone 37 research and development projects were funded with a sum of 4.2 million €. Examples for projects funded are: a) The development of rape asphalt for the environmentally sound repair of streets, b) ZERMEG – zero emission retrofit method for existing galvanising plants, c) PUIS – Produktbezogene Umweltinformationssysteme (product related environmental information systems) provide a platform for material data and environmental indicators of the whole life cycle for different consumer products.	A	Hazardous waste Industrial waste	http.//www.nachhalitgwirtschaften.at;
Positive and negative financial stimuli	**Subsidy Scheme for Investments of Local Administration on Waste Prevention** In 2002 the Flemish Government published a Subsidy Scheme for Investments on Waste Prevention. This Subsidy Scheme was established for local authorities willing to invest in facilities and services for waste prevention and waste management of household waste. Local authorities can file an application for subsidies at the OVAM (the Public waste Agency of Flanders). Subsidies are granted only for investments in services and facilities improving waste prevention and waste management of household waste. Subsidies can run up to 70% of the investment cost when it concerns investments on waste prevention and up to 50% when it concerns investments on waste management. Subsidies to improve waste prevention are given for reusable shopping bags, reusable beakers and lunchboxes, wormeries, compost bins....	BE	MSW	www.ovam.be, personal communication personal communication, OVAM, 2005
Positive and negative financial stimuli	**Taxes on certain types of packaging, bags, disposable tableware and PVC foils** A legal act on the tax on selected packaging was first introduced in 1977 and has since then frequently been amended and further developed to cover the present five separate tax systems: - A volume based tax, imposed on individual pieces of certain beverage containers.	DK	Plastic waste	http://www.skm.dk/foreign/english/2087.html, personal communication Mette Hyldebrandt-Larsen, ETC-

Strategy	Key example	Country	Targeted waste stream	Literature/Link
	- A weight and environmentally based tax on packaging for selected commodity groups - A weight based tax on paper and plastic bags - A weight based tax on disposable tableware - A weight based tax on PVC foils. Companies subject to the tax must register with the tax authorities. The companies must submit a monthly report to the tax authorities presenting their activities subject to taxation.			RWM, 2005
Positive and negative financial stimuli	**Tax deduction for municipalities which meet waste prevention targets in the Province of Mantua** Those municipalities which achieve a certain waste reduction target set by the Province, are eligible for a 5 % deduction on their waste tax/tariff. The decision, if the respective municipality has met its target is based on model calculations.	IT	MSW	personal communication Giancarlo Poltronieri, Provincial Observatory on waste, Province of Mantova, 2005
Positive and negative financial stimuli	**Carbon tax on packaging material** The Netherlands instituted a Waste Fund in 2007, financed by a carbon tax on packaging. The Waste Fund helps to pay for the separate collection of household packaging waste, while the tax encourages businesses to reduce the amount of packaging material used and to move towards the national recycling target: 42% of plastic packaging recycled by 2012. The tax is put on the carbon contents of non-renewable packaging material excluding logistics tools such as pallets, trolleys or large crates.	NL	Packaging	http://international.vrom.nl
Positive and negative financial stimuli	**Landfill tax** Several European countries (such as Norway or the Netherlands have introduced a tax on waste delivered for landfilling), partly as motivation for waste prevention. In the Netherlands the tax rate in 2006 was 85 €/tonne. In Austria the landfill levy is used for financing the decontamination of brown fields.	EU	All non-hazardous waste types	Huisman (2006), personal communication Pål Spillum, SFT, 2005
Positive and negative financial stimuli	**Deposit on one trip-beverage-packaging** Germany introduced a 0.25 € deposit on different types of one-trip beverage packaging in order to keep the market share of multi-trip-beverage packaging on a decent level. Sweden, Denmark and Estonia have similar systems.	GE, SW, DK, ES	Packaging	Umweltbundesamt (2006)
Prevention targets	**Voluntary agreement foundry sands** In 1992 a voluntary agreement was made between the foundry associations and the "Land" Baden-Württemberg in order to reduce the amount of foundry sands for disposal by 70 % within 4 years. The project was accompanied by the state owned ABAG consultant agency.	GE	Foundry sands (Hazardous waste)	www.abag-itm.de, personal communication Jürgen Schmid, ABAG-itm, 2005

Strategy	Key example	Country	Targeted waste stream	Literature/Link
Product standards	**Limiting the pollutant concentration in recycled construction material and its eluate** The Austrian Association of Recycling Construction Material (ÖBRV) in a guideline defined the technological standard for recycled construction material and limited the concentration of pollutants in this material and its eluates. The ÖBRV also introduced a voluntary quality assurance system based on third party certification. Recycling material which has passed all tests is marked by a certain label. In parallel to the guidelines, the Austrian federal Waste Management Plan defined the same pollutant concentration limits as “state of the art” to be applied. To further improve the legal basis, a corresponding ordinance is under preparation. Though at the first view a recycling measure, this initiative limits the pollutant contents in construction material and thus in the resulting secondary C&D-waste.	A	C&D	BMLFUW (2006), ÖBRV (2004)
Product standards	**Limitation and ban of cadmium, mercury and lead in different product groups** Since the 1970s some 20 EU directives and regulations have been issued to limit the use of cadmium, lead and mercury in products. The latest of these is the REACH Regulation (EC) No 1907/2006. Within this framework especially Nordic countries were active to further limit the distribution of these heavy metals. The Swedish Parliament has set the objective that newly produced consumer products are to the utmost possible extend be free from mercury by 2007 and free from cadmium and lead by 2010. Also the use of these heavy metals in production processes should be as low as possible. As of 2008 in Sweden a total ban of mercury was under discussion. In Denmark the sale of mercury except for dental amalgam is prohibited. In Norway for most products a limit value of 10 mg/kg was set for mercury. There the use of dental amalgam and mercury containing solders will be prohibited by 2010. With respect to cadmium Sweden has issued bans for stabilizing agents, pigments and surface treatment. The cadmium contents in fertilisers exceeding 100 g/t of phosphorous in the fertiliser is taxed. Denmark already in the year 2000 limited the concentration of lead in most products by 100 mg/kg. The same limit value is to be observed also in Norway. Existing exemptions may expire. In Finland, Flanders, Switzerland, the UK, Sweden, France and most German regions the use of lead-shot in wetlands is prohibited. There is also some restriction in Spain. In Sweden also the use of lead shot is banned from shooting ranges. In the Netherlands, Denmark and Norway the use of lead shot is completely prohibited. In Denmark, Sweden and the UK also the use of lead weights in fishery is prohibited or strongly restricted.	EU, DK, SW, NO	Hazardous waste	KEMI (2007). Robert Koch-Institut (2007): Norwegian Ministry of the Environment 2007 Umweltbundesamt & TU-Wien (2009)

Strategy	Key example	Country	Targeted waste stream	Literature/Link
Reuse	**Kringloop –Reuse-System with quality assurance in Flanders** Flanders has implemented a Reuse Centre system to prevent waste by facilitating the resale of discarded products. Apart from its environmental objective, Kringloop Reuse Centres also assume an important social function. The total Reuse system consists of 8 reuse centers and a chain of reuse shops dealing with clothing, electrical appliances, furniture, kitchenware, books, records, and bicycles. The system includes several means for the collection of goods: - Pick-up at home (including a free, scheduled house clear-out service for those moving to new properties) - Delivery to a Reuse Centre - Delivery to a municipal waste collection point The collected goods are then sorted (into saleable and non-saleable items), thoroughly checked, repaired or refurbished, and finally sold. For several products (washing machines, dryers, dishwashers, for example), the purchaser receives a 6 month warranty. About 3 % of the waste from electric and electronic equipment which is collected in these centres is reused. For Flanders with its 6 million inhabitants some 100 second-hand-shops have been installed. This chain of independent shops features a common design, quality management and marketing system resulting in a popularity which is comparable to well known furniture stores. In the year 2005 some 2.6 million clients were served by some 2600 permanently employed handicapped persons. The chain is 50 % co-financed by public funds.	BE	MSW, WEEE	http://www.kringloop.net/common/kvk.asp, Neitsch (2007)
Reuse	**ecomoebel – Reuse of furniture via regional recycling management** ecomoebel is the name of an innovative network for the reconditioning and marketing of used furniture. It is a cooperation-network with many partners, e.g. handicraftsmen, commerce, service providers and scientific organisations, in Dortmund, a city in the industrialized Ruhr area of Germany. The basic idea of the project is to combine the activities and know how of companies, organisations and small trade, acting thus far in an isolated manner, at a regional level. This idea is supported by the Federal Ministry for Education and Research of Germany. High quality standards for the refurbishment of used furniture guarantee proper ecomoebel. All furniture is analysed for harmful substances e.g. formaldehyde, and, if necessary, restored with environmentally sound products and substances like glue, oils, wax, lacquers. All results of the tests and all information concerning the restoration are shown in the certificate which forms part of every ecomoebel. The certificate is the basis of the ecomoebel quality signet, which guarantees low	GE	Furniture (wood)	http://www.ecomoebel.de/

Strategy	Key example	Country	Targeted waste stream	Literature/Link
	polluted furniture with a high quality standard. A consumer who buys an ecomoebel product will normally know more about his furniture than someone who buys new products in a large store. The potential buyer can either pre-select his ecomoebel on the computer screen using the ecomoebel internet platform or go directly to the ecomoebel network partner.			
Technology standards	**Limiting the hazardous substance contents in replacement fuels for cement kilns** A technical guideline limits the contents of hazardous substances in waste-materials which are used as energy carriers instead of conventional fuels. Within this scheme also the input of pollutants into cement kilns and thus the pollutant concentration in the resulting cement is limited, making this initiative a qualitative waste prevention measure.	A	C&D	BMLFUW (2008)
Voluntary agreements	**Take-back initiative for mercury thermometers** Mercury thermometers during the last decade were replaced by other types of thermometers. However, large numbers of mercury thermometers are still stored in drawers of private households ore used till they break. In order to reduce the environmental impact and a contamination of residual household waste with the mercury from the broken thermometers, in 2007 there was a 3 week initiative, based on a voluntary agreement between pharmacies and government, that pharmacies took back old mercury thermometers and replaced them by electronic thermometers at a much reduced price. Instead of the expected 50.000 mercury thermometers 1 million thermometers were collected within only 15 working days. This is 50 % of the mercury thermometers estimated to have been in private stock at that time.	A	Hazardous waste, MSW	Lebensministerium Pressestelle (2007)
Voluntary agreements	**“Let’s reduce waste. Don’t spend money at environment’s expense“** A voluntary agreement has been reached between the Province of Brescia and several supermarket chains. Informative brochures on eco-sustainable shopping were distributed at the supermarket entrance. Products with a low content in packaging were marked by eco-labels. In particular the supermarkets: 1) Identified and marked cleaner products such as: a) Items with a small share of packaging or with totally recyclable packaging (i.e. monomaterial). b) products without over packaging, c) food without plastic and polystyrene packaging (fruit, vegetables, unpacked or packed with cellophane only), d) glass bottled beverages, bottles with bigger capacity, e) detergents for home and person with refill or dispenser. 2) Kept a market share for new products complying with the aforementioned requirements. 3) Produced their own brand products reducing	IT	MSW, plastic	Personal communication Buratti Chiara Province of Brescia

Strategy	Key example	Country	Targeted waste stream	Literature/Link
	packaging and using eco-compatible materials. The Province took charge of promoting the project through advertisements on newspapers, radio and TV, with the aim of making the citizens more aware about the waste problem and suggesting virtuous behaviour.			
Voluntary agreements	**The Courtauld Commitment** The Courtauld Commitment is an agreement between thirteen major supermarket chains (representing over 90% of the UK grocery market) and WRAP, with the support of the UK Environment Ministry. The first commitment of the year 2005 had following targets: - to design out packaging waste growth by 2008; - to deliver absolute reductions in packaging waste by March 2010; and - to identify ways to tackle the problem of food waste and to reduce food waste arising by 150,000 tonnes in 2010 as compared to 2008. The Commitment was developed by WRAP's Retailer Initiative, and focuses on engaging support to find new packaging solutions so that less waste ends up in the household bin. This includes projects to reduce layers of packaging, to light-weight some packaging materials, and to do research into why the average UK consumer throws away € 600 worth of food every year. In 2010 a new commitment was agreed with following targets: - reduce the carbon impact of grocery packaging by 10 % - reduce UK household food and drink waste by 4 % - reduce grocery product waste in the supply chain by 5 %. Envisaged measures are: - Promotion of de-layering, light weighting, recycled content, refillables, self dispensing, concentrates, designing for recyclability, supporting increased collection for recycling, bulk importation and improved transport efficiencies to reduce packaging waste. - Support for consumers to buy the right amounts of food and drink by portioning, pack sizes, deli counter and loose and to get the most out of what they buy by date labelling and storage guidance, maximising shelf and home life promotions.	UK	Grocery product waste, food, packaging	www.wrap.org.uk/retail/courtauld_commitment

6.3 Impact of REACH

As concluded in chapter 6.1, hazardous materials and wastes are an area of high impact for prevention measures, especially for ecodesign, product standards and financial stimuli. The scope of the REACH Regulation is to ensure a high level of protection of human health and the environment by laying down provisions on substances and mixtures. The major provisions regulate the issue of sharing information within the material flow on hazardous properties of substances and mixtures, while some provisions impose specific use limitations, or exclude specific substances from being put on the market. The guiding principle is that manufacturers, importers and downstream users have to ensure that they manufacture, place on the market or use substances that do not adversely affect human health or the environment. Its provisions are underpinned by the precautionary principle. See article 1, aim and scope, of the Reach Regulation 1907/2006/EC.

There is a high similarity between some provisions in REACH and the scope of qualitative prevention where the use of hazardous substances is avoided in a design phase, as shown in Frame 8. REACH can either impose qualitative prevention by excluding the use of certain substances, or enable qualitative prevention by sharing information and making it easier for manufacturers to select alternatives for certain substances.

Article 2.2 of the Regulation excludes waste as defined in Directive 2006/12/EC from the definition of substance, mixture or article and thus from the application field of REACH. Article 3.37 on the contrary defines an exposure scenario as : *"the set of conditions, including operational conditions and risk management measures, that describe how the substance is manufactured or used during its life-cycle and how the manufacturer or importer controls, or recommends downstream users to control, exposures of humans and the environment. These exposure scenarios may cover one specific processor use or several processes or uses as appropriate"*. Although waste is not covered by REACH, exposure scenarios have to be developed for products being put on the market, taking into account the full life cycle including the waste phase. This corresponds also to qualitative prevention taking into account hazardous substances in the design phase in order to avoid environmental or health impact when the product becomes a waste. Even if REACH cannot be applied on waste, and the information obligations thus cease when a product becomes a waste, it still has to consider the exposure in the waste phase when developing and sharing the exposure scenarios in the production and use phase. For substances, for which a Chemical Safety Assessment (CSA) is required, and which are classified as dangerous according to Directive 67/548/EEC or Directive 1999/45/EC or are assessed to be a PBT or vPvB, the waste life stage of the substance needs to be covered by suitable exposure scenarios, the corresponding exposure estimation and the related risk characterisation. Additionally, general information on types, amounts and composition of waste occurring on manufacture and use of the substance are to be provided in the Technical Dossier (Annex VI, point 3.8). Downstream users receiving waste related information in an exposure scenario have the duty to implement this advice for their own activity and if relevant to forward the information to their customers. This includes waste handling at the downstream users' site, choosing appropriate routes of external disposal and/or recovery and informing customers on any waste related measures particularly needed to control risks. In other words, this results in harm prevention in the waste phase.

When a product ceases to be a waste, it re-enters the application field of the REACH Regulation. The REACH registrant must always consider the possible borderline between the REACH regime (from manufacturer to final downstream user) and the waste regime (from waste generator to final disposal or recovery operation). Between waste and product however exists a substantial grey area. This is especially true for substances that may indirectly or unintentionally be generated or for which the term 'discard' from the definition of waste can not be applied straightforward. But this is also the case for a waste that has gone through a re-use or recycling process, and where the transition point between waste and recycled material, or between preparation-for-reuse and reuse is less easy to interpret. The discussion on waste or non-waste essentially focuses the applicability of the waste regulatory frame or other frames like REACH. The question on the applicability of REACH is closely connected to the question of crossing the interrupted line in the figure below.

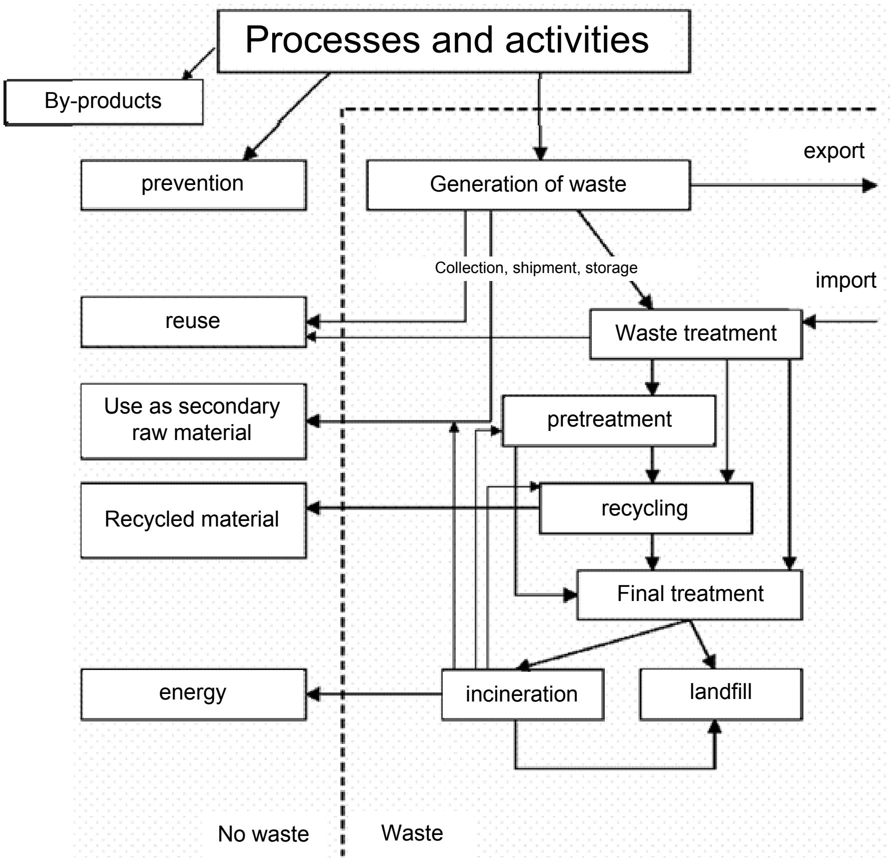


Figure 64: Borderline between waste and non-waste

Conclusion

REACH is an important instrument when trying to achieve effective waste prevention on hazardous waste.

- REACH can play its full role in the post-waste lifecycle stages of a product, e.g. when it is recycled and re-enters the market as a product or a non-waste raw material. The distinction between waste and non-waste is very important to assess the effect REACH can have.
- REACH can play a role in the qualitative prevention of the use of hazardous products that can end up in the waste phase. Both by excluding the use of certain substances, or by sharing information and thus sensitising the designer to use alternatives.

- REACH plays a role in harm prevention when handling the waste fractions, because the exposure scenarios to be developed include the waste phase as an integrated part of the life cycle.

6.4 Assessment of quantifiable impact in 2020

The matrix of high potential areas for prevention shows that metal waste and hazardous waste are the major waste streams to focus on. In chapter 4.5 a modelling exercise is performed to assess in a calculated way the future trends in waste generation and waste treatment from now to 2020. These results have been used as one of the input criteria for the multi criteria analysis to assess the areas of high potential. The exercise on future waste generation is however limited to the quantitative effects: the amount of waste. It can be used as an instrument to examine the quantitative effects of waste prevention measures on metals and on hazardous waste, but it cannot examine the effects of qualitative prevention, the avoidance of hazardous substances which is one of the key aspects of waste prevention on hazardous waste. As it uses waste generation within the EU-27 as a basic characteristic, it is also unable to assess the effects of hidden flows or waste generation due to extraction of metal ores outside the EU. Furthermore the detail on different waste streams is, due to lacking data, restricted to municipal solid waste.

Taking all these limitations into consideration, the effects of a successful waste prevention policy can be examined for the year 2020. Following premises are used in the calculation:

- Prevention policies start showing an effect from 2013 onwards and its effects slowly increase. For this reason data on effects in 2015 are rather meaningless, and 2020 is chosen as a time horizon.
- The effect of quantitative waste prevention is measurable as a decrease of the amount of generated waste per capita.
- The effect of progressive decoupling, differentiated over the types of Member States, is already taken into account in the baseline scenario.
- Because focus could be put on metals and on hazardous waste, the effect of prevention on these two waste streams will be higher than the effect on other waste streams. However a prevention effect is assumed for all waste streams but the effect of metal waste and hazardous waste is considered double as large.
- Different scenarios can be drafted for different success ratios of prevention policy. A high performing scenario calculates with prevention effect of 10% of waste generation, a moderate scenario with 5% and a low scenario with 2%.Of course it is not possible, based on the collected data in this high level study, to assess the success rate of concrete prevention measures.
- 2% of MSW is metal waste, 8% of MSW is hazardous waste from households

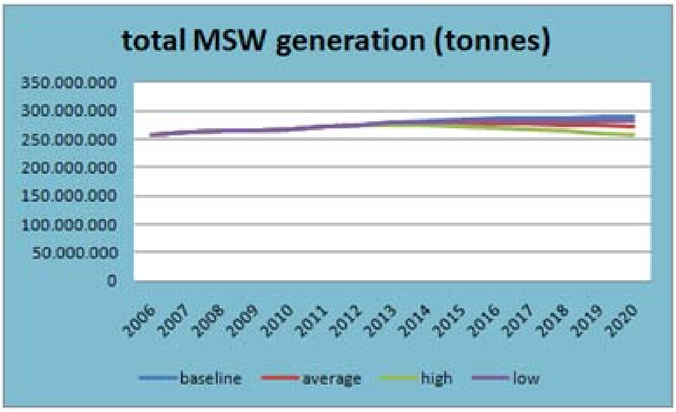


Figure 65: Effect of prevention on total MSW generation

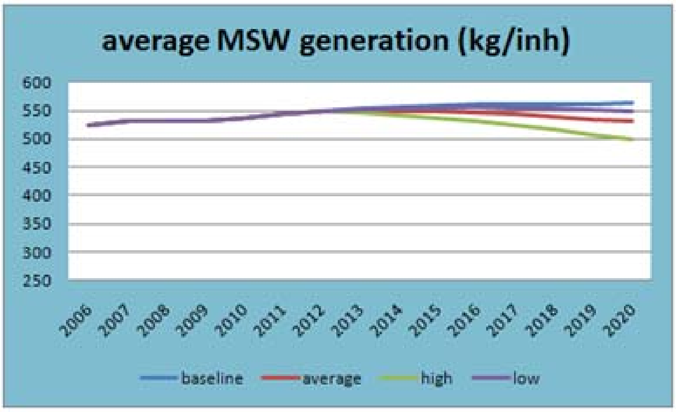


Figure 66: Effect of prevention on average MSW generation

If only on hazardous waste or on metal waste prevention measures would be applied, no important reduction in the total amount of generated MSW would be observed.

When taking into account above mentioned premises, the average generation of waste could decrease with between 12 to 62 kg/inh in 2020, and total generation could decrease between 6 to 32 million tonnes, compared to the baseline. However, compared to the actual situation assessed for 2010, both average and total waste still tend to increase.

	total; kt			
	baseline	average	high	low
2006	258.227.185	258.227.185	258.227.185	258.227.185
2007	262.912.937	262.912.937	262.912.937	262.912.937
2008	264.231.626	264.231.626	264.231.626	264.231.626
2009	264.134.690	264.134.690	264.134.690	264.134.690
2010	268.206.436	268.206.436	268.206.436	268.206.436
2011	272.379.787	272.379.787	272.379.787	272.379.787
2012	275.808.942	275.808.942	275.808.942	275.808.942
2013	279.289.683	277.369.566	275.449.449	278.521.635
2014	282.148.749	278.269.204	274.389.658	280.596.930
2015	284.038.415	278.180.122	272.321.830	281.695.098
2016	285.894.170	278.032.079	270.169.990	282.749.334
2017	286.881.315	277.019.770	267.158.225	282.936.697
2018	287.625.141	275.760.604	263.896.066	282.879.326
2019	288.317.865	274.442.568	260.567.271	282.767.746
2020	288.964.816	273.071.751	257.178.686	282.607.590

Table 61: Total MSW generation in different prevention scenarios

average; kg/inh			
baseline	average	high	low
524	524	524	524
531	531	531	531
531	531	531	531
531	531	531	531
537	537	537	537
543	543	543	543
548	548	548	548
553	550	546	552
557	550	542	554
559	548	536	555
562	546	531	555
562	543	523	554
562	539	516	553
562	535	508	551
562	531	501	550

Table 62: Average MSW generation in different prevention scenarios

6.5 Discussion and conclusions

A multi-criteria analysis (MCA) was carried out to define high potential areas for waste prevention. Because of lacking data, the assessment of especially the policy strategies was mainly based on expert opinion.

Following the MCA results, the high potential areas for waste prevention are hazardous waste and metal waste, and most promising prevention strategies are ecodesign and product standards.

Both preferred prevention strategies are characterized by their impact at an early phase of the life cycle of a product, so they are in line with the “prevention at source” principle.

A key example of a product standard and related ecodesign for preventing hazardous waste is the ban of NiCd-batteries. This resulted in a reduction of 69 to 77% of cadmium contents in residual household waste. [61]

In the MCA, we only looked at single measures and single waste streams. But of course, a waste prevention programme does not comprise the implementation of a single best measure, but a combination of mutually supportive measures.

There is a principle difference between waste prevention potentials of single measure - single product - single waste - single target person/company combinations and waste prevention potentials of strategies which shall affect several products/material streams and a target group. A single measure can have a very high effectiveness, like for example the significant reduction of cadmium in waste through the ban of NiCd-batteries. While a combination of strategies targeting a diverse set of products/materials and heterogeneous target group tends to have a lower effectiveness.

On the other hand, a combination of instruments or strategies compensates for the potential weaknesses of a single instrument, e.g. the long-term and unpredictable impact of social instruments, intensive implementation and enforcement requirements of regulatory instruments, and weak influence or political obstacles to economic instruments. Furthermore, different instruments and strategies can be used at different phases of the product-waste chain[62].

A waste prevention programme has to fulfill at least 2 principle tasks:

- To engage (to get the public and the experts so interested in waste prevention, that decision makers in policy and industry cannot help but investing in waste prevention)
- To enable (to give private consumers and industries the possibility to meet their needs with less environmental impact and in a more sustainable way)

In order to engage people and experts as well as making them concerned, waste prevention needs to climb up the agenda facilitated by motivation (marketing) campaigns on waste prevention.

In order to enable consumers and industries:

- eco-efficient products and services need to be developed (cfr. ecodesign, funding);
- eco-efficient products and services need to get available on the market (funding of demonstration/pilot projects, labeling and certification, providing organization help, removing legal barriers, marketing, GPP, put levies on inefficient technologies, etc);
- consumers and industries should be aware of what they are doing inefficiently (awareness campaign, audits);
- consumers and industries should be informed on what they can do better (information campaign, cleaner production advise, direct counseling).

[61] Abfallvermeidung und –verwertung in Österreich, Materialienband zum Bundes-Abfallwirtschaftsplan 2006. REP-0018, Wien. http://www.umweltbundesamt.at/fileadmin/site/publikationen/REP0018.pdf

[62] OECD (2002) Towards Sustainable Household Consumption? Trends and Policies in OECD Countries. OECD Policy Brief July 2002, pp 12

For example, a very effective measure is the ban of hazardous substances in certain products. But a precondition for the implementation of such measure is the existence of an eco-efficient, affordable alternative available on the market.

The effectiveness of a measure or combination of measure is hard to define. Consequently few data on the effectiveness of policy instruments and measures are available. Umweltsbundesamt in Austria collected a few waste prevention potentials for its waste management plan[63]:

- Reduction of cadmium contents in residual household waste by a ban of NiCd-batteries also in cordless power tools: 69 – 77 %.
- Reduction of heavy metals in household waste by increased repair and reuse: 1 – 13 %
- Reduction of residual household waste arising in test families which are intensely informed: 15 %
- Reduction of residual household waste arising in a whole town by a 9 measure waste prevention programme: 5-6 %
- Total realisable non-hazardous MSW prevention potential in a town: 4-8 %

Given the limited data availability, the performed MCA only gives a rough idea of high potential strategies and waste streams to be targeted. Hazardous waste and metal waste are key areas according to the MCA, because of their high environmental impact and amount of hidden flows. But to define the most optimal set of measures or strategies a more profound analysis is necessary. Ecodesign and product standards are effective strategies that are in line with the polluter pays principle and prevention at source principle, but they need to be combined with supportive measures. A well combined set should be designed that aims for the long-term sustainable development of our economic system.

[63] Abfallvermeidung und –verwertung in Österreich, Materialienband zum Bundes-Abfallwirtschaftsplan 2006. REP-0018, Wien. http://www.umweltbundesamt.at/fileadmin/site/publikationen/REP0018.pdf

7 Task 5: initial catalogue of indicators to measure and describe waste prevention

7.1 Situation

7.1.1 Measuring what is not there

The effectiveness of prevention measures is very difficult to assess. Waste prevention is often a long-term policy for which the results of the measures are difficult to observe in the short-term. Furthermore, prevention is an assembly term for all efforts that are consciously and deliberately made to avoid the production of certain waste or to avoid or diminish the hazardousness of the waste and its constituents. For the concept of harm prevention, see chapter 3.7, prevention is very hard to monitor directly, as it often adds up to “measuring what is not there”. To measure quantitative waste prevention is to measure a non-existent amount of waste. To measure qualitative waste prevention is to measure harm that did not occur.

One might argue that measuring prevention demands a clear and proven causality between the preventive measures undertaken and the evolution of the quantity and quality (or harmful characteristics) of the waste. To prove such causality, it is necessary to make abstraction of all other factors influencing the quantity and quality of waste. The growth in the amounts of waste generated depends on a wide and complex range of factors, including the levels of economic activity and cyclical movements like fluctuations in the markets, demographic changes (e.g. number and size of households), technological innovations, cultural aspects on life-style, commercial prices of recycled materials and even climatologic factors (e.g. quantities of garden waste). It is very difficult to exclude these effects in practice to measure the effect of the prevention measure.

7.1.2 Types of indicators

Paragraph 3.2.1 illustrates the very peculiar position waste prevention and waste prevention indicators take in the policy cycle as described by the DPSIR model. Most waste indicators focus on pressure or state. Prevention policies are typical response actions, and require indicators to measure the response. Two different strategies are open to obtain this: a direct assessment of e.g. the size or degree of participation on specific response actions, or an indirect assessment of the results of the action on pressure and state. The first can be described as an output indicator, the second as an outcome indicator.

To the first category or output indicators belong prevention-indicators that count the number of leaflets or other instruments that have been used, the degree on knowledge and interest in eco-efficiency present in certain industrial sectors etc… The usual measuring methodology exists in applying direct questionnaires or indirect administrative sources. The big advantage of this indicator is the strict link to the measure itself, whilst the disadvantage is the presumed but not proved beneficial effect or outcome on the environment.

To the second category or outcome indicators belong indicators on impact and state, and the evolution of these through time. The big advantage is that the environmental impact is measured; the disadvantage is that the relationship to the preventive action is presumed but not proven.

Both categories of indicators suffer from a kind of Heisenberg uncertainty. In quantum physics, the Heisenberg uncertainty principle states that locating a particle in a small region of space makes the momentum of the particle uncertain; and conversely, that measuring the momentum of a particle precisely makes the position uncertain. You cannot know simultaneously place and momentum of a particle. Applied on waste prevention, with one indicator you can measure one of two aspects, but not both together. If an indicator depends upon a direct measurement of the application of an instrument (output indicator), you have detailed information on the instrument but you do not know the real impact of this instrument on the environment. If you measure the impact directly (outcome indicator), you have detailed information on the impact but you are uncertain on the relationship between the instrument and the impact. Both categories of indicators cannot be integrated but they are both necessary to make meaningful judgements on the applied prevention policies.

7.1.3 Properties of good indicators

Indicators are to be developed and selected in function of following qualities:

- pertinence of the indicator, giving answers to the right questions;
- availability of sufficient rough data or information as raw material to construct the indicator;
- transferability of the indicator to other countries and markets, or to other waste streams or industrial sectors;
- popularity, frequency of use of this type of indicator;
- compatibility with Community data and other waste indicators;
- degree of maturity of the indicator, proven quality and support;
- scientific and statistic reliability, credibility and robustness of the indicator.

7.2 Inventory of most promising indicators

7.2.1 Output indicators

7.2.1.1 Flemish case

The basic characteristic of output indicators is their direct link to policy instruments. These instruments vary between Member States and therefore it is difficult to propose EU-wide applicable indicators. As a case study the output indicators applied by the Flemish Region of Belgium are discussed.[64] They are selected end 2007 actualising a list of prevention indicators in use since 2002. The advantage of the used study is that an analysis is made on tested and rejected indicators as well as on successful indicators. The drawback of the study is that it is limited to municipal waste prevention.

Following waste prevention indicators have been selected:

- The number of distributed no-thanks stickers fort unsolicited mail. A no-thanks sticker is a tool, either voluntarily of supported by local or regional legal provisions, to prevent non addressed advertisements to be dropped in letter boxes of private persons. The indicator is the number of families that have received and/or used such a sticker compared with the total number of families in Flanders

[64] OVAM, Indicatoren voor de preventie van huishoudelijke afvalstoffen in Vlaanderen (2007)

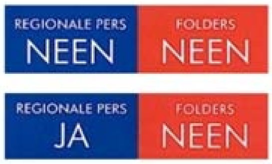


Figure 67: Sticker no-no and yes-no for free regional press and unsolicited publicity

- The use of second hand/reuse goods. The indicator is the quantity in kg of goods being reused compared to the number of inhabitants served by a reuse centre. In Flanders reuse centres are usually municipally or inter-municipally organised centres for refurbishment and reuse of goods that have been disposed off (furniture, EEE, textiles, …)
- The number of backyard composters. The indicator is the number of families possessing an individual backyard composter compared to the total number of Flemish families. This indicator only makes sense if (as is the case in Flanders) backyard composting is considered to be a waste prevention activity. See Frame 1 on page 55.

Figure 68: Backyard composter

- Share of reusable household packaging. The indicator is the percentage in weight of reusable household packaging material compared to the total amount of household packaging.
- Packaging per consumption unit. The indicator is the total amount on single use packaging being put on the market, compared with the household expenditures for buying consumer goods.
- The circulation of publicity folders. The indicator is expressed in kilogram.

Following indicators have been rejected after testing:

- Number of contacts between private persons and compost masters, volunteers trained by the municipalities to support backyard composting on demo sites usually near the civic amenity sites for waste. Too many uncertainties existed and too many assumptions had to be made to make this into a robust indicator to measure backyard composting.
- The number of private persons asking for prevention information. Too many intermediaries provide information to allow for an effective data collection, and the information is too frequently not only focussing on prevention but also on recycling, sorting and other waste and environment related actions or attitudes to use it as an indicator for municipal waste prevention.
- Participation in eco-teams. An eco-team usually consists of a group of volunteers or households that try to live in an environmentally friendly way. An eco-team meets

once a month to discuss a particular theme: waste, consumption, transport, electricity, heating and water savings. In addition, each participant decides for himself how far to go in carrying out the tips. The indicator is abolished because eco-teams focus on more than only waste prevention, and because it is not clear how representative participation in eco-teams is for the population being active on waste prevention.

- People participating in the Robinson list. A Robinson list is an opt-out list of people who do not wish to receive marketing transmissions. A Robinson list usually is funded by the direct mail industry which collects names and addresses of people who do not want to receive direct marketing. This list is circulated to marketing companies which are then responsible for not contacting people on the list. Participation on the Robinson list is not used as a direct prevention indicator because it is not clear which amount of waste has been prevented, and because of some practical problems on data accessibility.
- Enquiry on waste prevention attitude of households. A two-yearly direct questionnaire to divide the population in four groups regarding waste prevention: no interest, interest, implementation and routine. This is considered a useful indicator, but until now has not yet been implemented in a structured way.
- Ratio between packaging waste and amount of products sold. Due to lacking reliable basic data this indicator cannot be used. See also paragraph 7.2.2.3.
- Following indicators have been rejected due to lacking data sources:
  - The balance between sold new and sold second hand goods for specific product categories
  - Turnover of cotton diapers
  - Turnover of beverages in returnable packaging with deposit
  - Turnover of refillable packaging of detergents
  - Relation between primary, secondary and tertiary packaging for household products, starting from the idea that prevention on primary packaging may influence secondary and tertiary packaging

7.2.1.2 OECD waste response indicators

In its landmark study ‘Towards waste prevention performance indicators[65]’ the OECD working group on waste prevention and recycling combined with the working group on environmental information and outlooks discerns three types of waste prevention indicators:

- Pressure indicators and drivers of waste generation. These are outcome indicators, discussed in chapter 7.2.2.1.
- Response indicators, discussed below
- Indicators based on Material Flow Accounts, a specific type of pressure indicators, discussed as well in chapter 7.2.2.1.

The proposed methodology for response indicators was to identify a number of indicators to measure the implementation of OECD member countries’ objectives and instruments relating to waste prevention. However, this approach has proved less suitable, since polices and instruments vary greatly among the countries surveyed. It was demonstrated

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[65] OECD Environmental Directorate, Towards waste prevention performance indicators (2004)

that very few countries have targets that go beyond the general objective of waste prevention. Furthermore, relatively few measurable targets have been set for municipal waste, let alone other waste streams such as paper and packaging. The survey of policies and instruments implemented in OECD member countries revealed that the choices of instruments differ widely from one country to another. The intention was to study similarities among policies and use them to develop response indicators. However, with the differences in policies, this did not seem to be a feasible approach. Fees and charges in municipal waste management seemed to be the only type of instrument that is in wide use.

Moreover, measures targeting the design and production process are considered very important to achieve waste prevention. If waste is to be made less hazardous, if reuse systems are to be set up and if a reduction in waste quantities is to take place then several responses and incentives have to be implemented upstream especially in the phases of design, manufacturing and distribution of products. The development of response indicators on waste prevention should therefore include all phases of the product life cycle. Unless measures are targeted within particular sectors, upstream measures are often of a generic nature, which makes it difficult to assign them to specific waste streams.

Suggested **response indicators for the short-to-medium-term** purposes are:

- Certified environmental management systems (EMS). The indicator is the number of companies with a certified environmental management system (EMS), total number, per capita, or per GDP. Additional information:
  - Public programmes to support or ease implementation of EMS;
  - EMS distribution across the economic sectors;
  - Share of small and medium sized enterprises with a certified EMS of total companies with certified EMS; and
  - Annual turnover of the companies with EMS.

  The number of certifications could be used as a signal about enterprises' interest in incorporating environmental considerations, including waste prevention, into the manufacturing industry.
- Consumption and recycling of selected materials. In general, recycling of materials will save resources and eventually reduce the generation of waste (see paragraph 3.3.3.2). Exactly how much, depends on the kind of material, where it is extracted, produced, used energy sources, waste management practises, etc. The indicator OECD suggests is consumption of virgin material and (collection for) recycling of the same material. For selected materials only, like glass, paper and metals. Additional information:
  - Description of legislation, requirement for separate collection (e.g. kerbside, bring scheme, other), extent of deposit-refund systems;
  - Recycling targets for the material in question;
  - Development in prices for recycled products; and
  - Development in GDP and production volume using this particular material.

  It remains difficult to describe this OECD outcome indicator for recycling as an output indicator for waste prevention. OECD applies the idea of recycling as a tool to enhance prevention, and therefore the outcome indicator for recycling as an output indicator for the prevention-promoting-instrument which is recycling.

- No-thanks sticker for unsolicited mail. The indicator, in line with the OVAM indicator mentioned above, is the number of no-thanks stickers handed out, in percentage of total households or by type of households (single-family, multi-family, other). Additional information:
  - Year of introduction;
  - Legislation or coverage of the measure, e.g. how widely stickers are circulated and used, possible registration requirements and compliance requirements for the mail provider, etc;
  - Launched information campaigns; and
  - Monitoring arrangements.

Suggested **response indicators for the long-term** purposes are:

- National waste prevention strategies and plans. The indicator is the existence of a national waste prevention plan or strategy (yes/no). Additional information:
  - Year of issue;
  - Is the plan/strategy subjected to a regular revision process;
  - Target audience of the plan or strategy;
  - Public annual expenditure on cleaner production programmes in % of GDP; and
  - Public annual expenditure per capita on consumer awareness-raising.

  This indicator will be outdated for Member States as the development of a waste prevention plan becomes obligatory under application of article 29 of the Waste Framework Directive.
- Extended Producer Responsibility Schemes (EPR). The indicator could be a qualitative indicator that shows the extent to which EPRs are implemented. In this case a relevant indicator could be a list of (a number of) products and/or product groups targeted by EPR nationally or regionally. Additional information:
  - The share of companies participating in a compliance scheme over those targeted by EPR (by law or by voluntary agreement with industry organisation, etc.);
  - In some cases, third-party organisations finance prevention programmes directly by devoting a part of their budget to this activity. These expenses can be a useful indicator to be compared with the amount products or product groups put on the market;
  - Information on possible waste prevention targets; and
  - Information on costs and revenues of EPR, i.e. total revenues minus total costs of the system.

  This indicator is especially interesting for non obligatory EPR schemes not included in the different waste stream directives.
- Households with variable-rate pricing. The indicator is the number of households with variable-rate pricing (or pay-as-you throw schemes), in total or as share of total number of households. Additional information:
  - Share of volume-based, weight-based pricing and hybrids versus other payment systems, including the number of households with a reduced fee for home composting, etc.; and

- Fees per tonne waste covering full costs or comparable tax subsidies.

This indicator is focussing on source separation and separate waste collection which can have an impact on qualitative waste prevention in the waste treatment phase, but which is usually not accounted for when evaluating prevention.

7.2.2 Outcome indicators

7.2.2.1 General waste statistics acting as a prevention indicator

The mere quantity of generated waste, in total, per capita, per GDP-unit is considered a useful indicator for waste prevention. If the quantity diminishes, prevention initiatives are assumed to be successful, or in any case the scope of prevention is reached. Of course only quantitative prevention is covered by this type of indicator, while prevention usually is more complex than merely reducing the amount of waste.

OVAM[66] uses following indicators for household waste prevention:

- Household waste generation per capita
- Household waste generation per unit of consumption. GDP is used as a benchmark, but as the GDP includes as well public spending a more precise data source is needed. In the national accounts a value for 'private consumptive expenses' can be retrieved which is a better value to use as a denominator in this indicator. An even more detailed split up is needed to take out all expenses for services or other expenses not generating waste. The Belgian National Institute for Statistics publishes the results of a household budget survey, which enables a split up between relevant expenditures.

OECD[67] proposes:

- Municipal waste generation in tonnes/year, kg/inh.year and kg/private final consumption. These indicators correspond with the OVAM indicators as mentioned above, but with a slightly lower level of detail.
- Generation of construction and demolition waste in tonnes/year or in tonnes/GDP.year
- Generation of non-hazardous industrial waste in tonnes/year or in tonnes/GDP.year

The OECD key environmental indicators (KEI)[68] include:

- Municipal waste generation intensities, kg/inh.year, kg/PFC[69].year and total municipal waste generation in kg/year, both expressed as a percentage of the 1980 value.
- Total waste generation intensities, indicators derived from material flow accounting. This is a medium term indicator – an indicator that requires further specification and development (availability of basic data sets, underlying concepts and definitions).

The OECD core set of environmental indicators (CEI) includes:

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[66] OVAM, Indicatoren voor de preventie van huishoudelijke afvalstoffen in Vlaanderen (2007)
[67] OECD Environmental Directorate, Towards waste prevention performance indicators (2004)
[68] OECD, Key Environmental Indicators (2004)
[69] PFC : private final consumption in US dollar

- Generation of:
  - municipal waste
  - industrial waste
  - hazardous waste
  - nuclear waste
- Pressure indicators:
  - Movements of hazardous waste
- Conditions: effects on water and air quality; effects on land use and soil quality; toxic contamination
- Responses
  - Waste minimisation = Recycling rates
  - Economic and fiscal instruments, expenditures

OECD states: Despite considerable progress, data on waste generation and disposal remains weak in many countries. Further efforts are needed to ensure an appropriate monitoring of waste flows and of related management practices, and their changes over time, to improve the completeness and international comparability of the data, as well as their timeliness. More work needs to be done to improve data on industrial and hazardous wastes, and to develop indicators that better reflect waste minimisation efforts, and in particular waste prevention measures. The usefulness of indicators derived from material flow accounting should be further explored.

The **EEA**[70] uses:

- Generation of municipal waste in kg/inh.year
- Generation of packaging waste
- Direct Material Input (DMI)
- Direct Material Consumption (DMC) - Edition 2006 (see also paragraph 7.2.2.2)
- Total generation of waste
- Generation of manufacturing waste
- Generation of hazardous waste
- Waste recovery, specific waste streams (sewage sludge, waste oils, waste tyres, municipal waste and packaging waste)
- Waste disposal, specific waste streams (sewage sludge, waste oils, waste tyres, municipal waste and packaging waste)

Some of these indicators can be used in the frame of indicating possible quantitative waste prevention, while other only focus the treatment phase.

Many more waste generation indicators can be proposed, e.g. based on the reported categories according to the first annex of the Waste Statistics Regulation.

Table 63: Data on waste generation and treatment operations as available from the reporting for the Waste Statistics Regulation

[70] http://scp.eionet.europa.eu/facts/indicators - Indicator based assessments on waste and resource use,

		annex 1 : data on generation per industrial sector	annex 2: data on waste treatment operations:		
			incineration	recovery	disposal
1	01.1	Spent solvents	x		x
2	01.2	Acid, alkaline or saline wastes Non hazardous	x		x
3	01.2	Acid, alkaline or saline wastes Hazardous	x		x
4	01.3	Used oils	x	x	x
5	01.4	Spent chemical catalysts Non-hazardous	x		x
6	01.4	Spent chemical catalysts Hazardous	x		x
7	02	Chemical preparation wastes Non-hazardous	x		x
8	02	Chemical preparation wastes Hazardous	x		x
9	03.1	Chemical deposits and residues Non-hazardous	x		x
10	03.1	Chemical deposits and residues Hazardous	x		x
11	03.2	Industrial effluent sludges Non-hazardous	x		x
12	03.2	Industrial effluent sludges Hazardous	x		x
13	05	Health care and biological wastes Non-hazardous	x		x
14	05	Health care and biological wastes Hazardous	x		x
15	06	Metallic wastes Non-hazardous		x	
16	06	Metallic wastes Hazardous		x	
17	07.1	Glass wastes Non Hazardous		x	
18	07.1	Glass wastes Hazardous		x	
19	07.2	Paper and cardboard wastes		x	
20	07.3	Rubber wastes		x	
21	07.4	Plastic wastes		x	
22	07.5	Wood wastes Non-hazardous		x	
23	07.5	Wood wastes Hazardous			
24	07.6	Textile wastes		x	
25	07.7	Waste containing PCB	x		
26	08	Discarded equipment Non-hazardous			
27	08	Discarded equipment Hazardous			
28	08.1	Discarded vehicles Non-hazardous			
29	08.1	Discarded vehicles Hazardous			
30	08.41	Batteries and accumulators wastes Non-hazardous			
31	08.41	Batteries and accumulators wastes Hazardous			
32	09	Animal and vegetal wastes		x	x
33	09.11	Animal waste of food preparation and products		x	x
34	09.3	Animal faeces, urine and manure		x	x
35	10.1	Household and similar wastes	x		x
36	10.2	Mixed and undifferentiated materials Non-hazardous	x		x
37	10.2	Mixed and undifferentiated materials Hazardous	x		x
38	10.3	Sorting residues Non-hazardous	x		x
39	10.3	Sorting residues Hazardous	x		x
40	11	Common sludges (excluding dredging spoils)	x		x
41	11.3	Dredging spoils Non-hazardous	x		x
42	12.1+12.2	Mineral wastes (excluding combustion…) Non Hazardous		x	x
43	12.1+12.2	Mineral wastes (excluding combustion…) Hazardous		x	x
44	12.4	Combustion wastes Non-hazardous			x
45	12.4	Combustion wastes Hazardous			x
46	12.6	Contaminated soils and polluted dredging spoils			x
47	13	Solidified, stabilised or vitrified wastes Non-hazardous			
48	13	Solidified, stabilised or vitrified wastes Hazardous			

7.2.2.2 Case "indicators based on material flow accounts"

OECD[71] observes concerns on the increasing and expanding use of natural resources both in production and consumption. The economic growth, supplemented with parallel growth in resource use is considered to be inconsistent with sustainable development. The only sustainable way to solve this problem is to motivate reductions in the use of natural resources. Reductions in emissions to air and water and in waste generation are

[71] OECD Environmental Directorate, Towards waste prevention performance indicators (2004)

the first step towards this goal, but the second step is to improve the durability of products and to reduce the material use in their production.

Waste management should no longer be considered only the last step in the material cycle. Rather, waste management should be considered an integral part of the sustainable materials management. Waste and waste prevention need to be addressed in the framework of the material flow accounting (MFA) and material balance of societies.

The most important arguments used by OECD for this approach are:

- Via material flow accounting waste and waste issues can be linked to economic development;
- Waste issues can be split into fractions according to their importance in the accounts;
- Waste generation can be examined in relation to material inputs and material uses;
- Conventional waste definitions need not to be fully respected; and
- Waste indicators can be established as comprehensively as other policy indicators.

The proposed indicators and methodology serve to:

- Estimate waste generation by using data on the production and consumption of materials and key economic variables in situations where sufficient waste data do not exist;
- Produce efficiency indicators that would describe linkages between material use, waste generation and economic development. Efficiency means essentially that resources are not wasted and that maximum aggregate wellbeing is derived from a given stock of resources. Eco-efficiency involves the delivery of competitively-priced goods and services that satisfy human needs and bring quality of life, while progressively reducing ecological impacts and resource intensity throughout the life cycle, to a level at least in line with the earth's estimated carrying capacity.
- Develop indicators that would reveal the effects of policies and other measures aimed at preventing waste generation.

The starting-point of the OECD approach is the observation that economy-wide statistics on economic development and material flows are not sufficient, if the purpose is to evaluate or enhance waste prevention policies. Waste prevention policies should be evaluated by the industrial branches due to the fact that the branches greatly differ from each others both in respect to material throughput, economic development and environmental protection, and in respect to possibilities to reduce waste generation.

Economies are connected with the surrounding environment via material and energy flows. Economy-wide material flow accounts (MFA) and balances demonstrate

- the amounts of physical inputs into an economy,
- material accumulation in the economy (stocks), and
- outputs to other economies or back to nature.

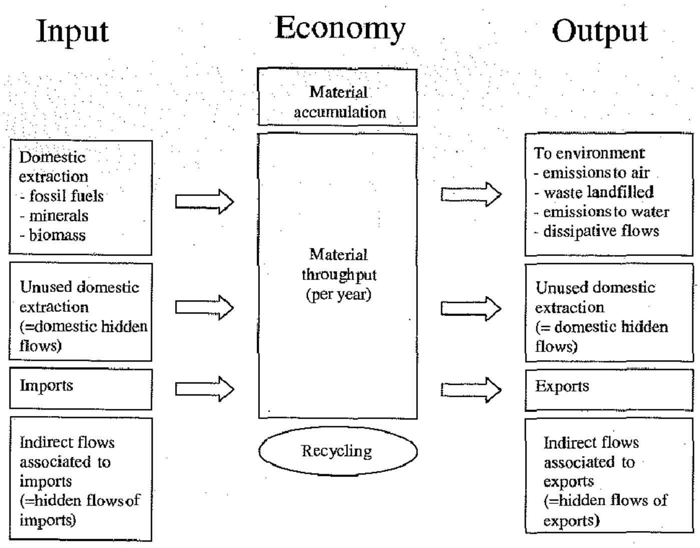

Figure 69: Schematic description of the material balance framework at national level

EUROSTAT has developed a practical modification of the economy-wide material balance scheme for statistical purposes. This composite economy-wide material balance with derived resource use indicators and definitions of the basic concepts of the balance is presented

INPUTS (origin)	OUTPUTS (destination)
Domestic extraction Fossil fuels Minerals Biomass + Imports = **DMI** direct material inputs + Unused domestic extraction from mining/quarrying from biomass harvest soil excavation = **TMI** total material input + Indirect flows associated to imports = **TMR** total material requirements	Emissions and wastes Emissions to air Waste landfilled Emissions to water + Dissipative use of products and losses = **DPO** domestic processed output to nature + Disposal of unused domestic extraction From mining/quarrying From biomass harvest Soil excavation = **TDO** total domestic output to nature + Exports = **TMO** total material output + Net additions to stock infrastructure and buildings Other (machinery durable goods, etc) + Indirect flows associated to exports
Domestic extraction: All solid liquid and gaseous materials (excluding water and air but including e.g. the water content of materials) that are taken from domestic natural resources and enter the economy for further use in production or consumption processes *Imports:* Raw materials and manufactured products that are imported and enter the economy for further use *Direct Material Inputs (DM1)* = Domestic extraction plus imports *Unused domestic extraction (Hidden Flows)*: Materials that are moved on a nation's territory on purpose and by means of technology but are not fit or intended for use. Unused domestic extraction include such as soil and rock excavated	

during construction, dredged sediments from harbours, overburden from mining and quarrying and unused biomass from harvest.
Total Material inputs (TMI) = Direct material inputs plus Unused domestic extraction (Hidden flows)
Indirect flows associated to imports (Hidden flows of imports): Direct inputs used and unused extraction generated abroad in producing products for export but which are not included in the quantities of exported raw materials and manufactured products.
Total material requirements (TMR) = Direct material inputs plus Unused domestic extraction plus Indirect flows associated to imports
Emissions and wastes: Gaseous and solid emissions to air, final placement of solid waste to landfills and emissions of materials to water
Dissipative use of products and dissipative losses: Materials which are dispersed deliberately into the environment or unavoidable consequence of product use These are mainly use on agricultural land (fertiliser, manure etc), use on roads (sand, salt etc) and losses (corrosion and abrasion of products and infrastructures, leakage etc.).
Disposal of unused domestic extraction equals the Unused domestic extraction in the input side of the balance.
Domestic processed output to nature (DPO) = Emissions and waste plus Dissipative use of products and losses
Total domestic output to nature (TDO) = Domestic processed output to nature (DPO) plus Disposal of unused domestic extraction
Total material output (TMO) = Total domestic output to nature (TDO) plus Exports
Net additions to stock: Gross additions minus removals of materials in infrastructures and buildings, machinery, durable goods etc… This item does not include stocks related to human bodies and livestock, cultivated forests and landfills but may include wastes which are stored for treatment in the near future.
Indirect flows associated to exports (Hidden flows of exports): Defined correspondingly to Hidden flows of imports

Indicators for prevention, proposed by OECD, are described as follows:

- Direct material input (DMI) and domestic hidden flows are decoupled from gross domestic product GDP. Such a decoupling may be caused by:
  - Taken preventive measures for waste generation, e.g. investments in cleaner technology;
  - Increased recovery of materials, since that decreases the use of virgin natural resources in production processes;
  - Economic regression periods;
  - Closing of mines;
  - The increase in imports of raw materials; and
  - Structural changes of the economy due to the rapid growth of branches with little material intensity (e.g. electronics).
- Total material input per GDP diminishes.

7.2.2.3 Case “packaging waste essential requirements”

Target

The indicator developed below aims to measure compliance with the Essential Requirement as defined in the Packaging and Packaging Waste Directive annex II: *Packaging shall be so manufactured that the packaging volume and weight be limited to* *the minimum adequate amount to maintain the necessary level of safety, hygiene and acceptance for the packed product and for the consumer.*[72]

Definition of the indicator

The indicator aims at proving or contradicting the statement that the volume of packaging used is diminishing, related to the amount of packed goods that are being put on the market. Based on available official statistics, an indicator can be developed to evaluate if the ratio between the quantity of packed product and the quantity of used packaging is diminishing, in line with the provisions in the requirement on prevention to limit the packaging volume and weight to the necessary minimum.

The indicator can roughly be presented as follows:

$$d\left(\frac{\Sigma\, packaging}{\Sigma\, packed\ \ product}\right)\Big/ dt$$

Equation 5: Indicator for the first Essential Requirement for packaging waste

The proposed indicator is monitoring the whole market of a Member States and has the ambition to assess if the ratio between packaging and packed products is diminishing over time. This could be indicative for positive evolutions in compliance with the requirement on prevention. It does not respond to the question if this is a spontaneous market evolution, the result of deliberate prevention measures taken by industry, or the effect of successful policy and legal measures taken by government to implement the requirement on prevention. It is a clear outcome indicator. However if we assume that some specific policy measures taken by Member States are effective, we should be able to observe a difference in the indicator between these Member States and other Member States.

Each Member State uses its own methodology and includes its own assumptions to calculate the amount of packaging waste. Therefore, comparison and benchmarking between countries is difficult. However, when a Member State uses the same methodology each year it can still serve as a basis to evaluate the changing balance between packaging and product. The change in this balance is the indicator for the compliance with the requirement on prevention. It can be compared between Member States and a benchmarking exercise can divide Member States between states with an increasing ratio, a diminishing ratio or a stabilised ratio.

Available data sources

The **quantity of packaging waste** has a linear correlation with the amount of packaging used in a country. Every single-use packaging of a product that is put on the market ends up as packaging waste. There is a simple one-to-one relation. Reusable packaging at the end of its lifetime ends up once in the packaging waste fraction, even if it has been used several times to pack products that have been set on the market. This does not distort the indicator for the requirement on prevention. The use of reusable packaging will lower the ratio packaging/packed product but this is acceptable. The use of reusable packaging

[72] ARCADIS for DG ENV, A Survey on compliance with the Essential Requirements in the Member States (ENV.G.4/ETU/2008/0088r) (2009)

does not lower the amount of packaging used for a single product, often this is the opposite as reusable packaging ends to be more robust, but is does lower the total quantity of material used for packing a product at the scale of the total economy in a year.

As the official indicator value for the quantity of packaging waste, the EUROSTAT Environmental data Centre on Waste is used as a data source.[73]

The **quantity of products put on the market** can be assessed either directly, from the PRODCOM and COMEXT databases of EUROSTAT, or indirectly using an indicator like the GDP. The quantity of products put on the market in a Member State can be assessed as the total manufacture of goods plus the amount of good imported minus the amount of goods exported. The PRODCOM statistics on production need to be filtered, based on the CN codes, for manufactured products that are usually marketed in a packed way, excluding electricity, fuels and mining and quarrying output, that are distributed without packaging. The COMEXT external trade statistics cover all goods exchanged by the EU Member States, Candidates countries and EFTA countries with all partner countries (including EU Member States).

The GDP (gross domestic product) is an indicator for a nation's economic situation. It reflects the total value of all goods and services produced less the value of goods and services used for intermediate consumption in their production. Expressing GDP in PPS (purchasing power standards) eliminates differences in price levels between countries, and calculations on a per head basis allows for the comparison of economies significantly different in absolute size.

It should be taken into account that packaging is not only related to products, but that some services require packaging as well, e.g. laundry services. However, most packaging is product related. In some case, the volume is the most interesting parameter, in other cases the weight or the composition of the packaging.

The data from PRODCOM and COMEXT do contain some important gaps. Therefore, it needs to be examined if these data are usable, or if a more indirect indicator like the GDP could be used as a more stable and robust alternative. It can be assumed that GDP is linearly and strongly connected to the amount of product put on a national market.

Outcome

Basic data on packaging waste quantities are easily retrievable from the data reported in the frame of the Packaging and Packaging Waste Directive. They are not fit for comparison between Member States. We assume however that most Member States keep their method for data gathering and calculation rather stable over the years. Reported data are rather consistent over the years. They show in general an augmenting trend.

Table 64: Packaging waste generated in MS

tonnes	2000	2001	2002	2003	2004	2005	2006
Austria	1.170.000	1.096.650	1.059.000	1.159.972	1.101.839	1.111.400	1.166.352
Belgium	1.496.290	1.423.542	1.490.200	1.623.591	1.631.905	1.659.443	1.665.533

[73] European Commission > Eurostat > Environmental Data Centre on Waste (http://epp.eurostat.ec.europa.eu/portal/page/portal/waste/data/packaging_waste)

- Packaging waste, Data 2006 (update 18 December 2008)
- Packaging waste generation, recovery and incineration, Data 1997 – 2005 (DG environment website)

Bulgaria						520.192	430.480
Cyprus					145.056	123.066	63.065
Czech Rep				720.158	775.981	847.445	898.668
Denmark	852.258	864.616	856.716	956.774	948.870	983.011	970.890
Estonia					131.371	137.189	152.135
Finland	442.500	457.100	451.300	616.000	649.500	688.820	677.000
France	12.499.000	12.336.000	12.275.000	12.333.740	12.382.970	12.360.928	12.667.985
Germany	15.121.100	15.017.800	15.434.700	15.465.800	15.516.900	15.470.500	16.132.765
Greece	934.500	974.500	994.700	1.014.000	1.038.000	1.061.005	1.056.000
Hungary					815.000	853.044	884.957
Ireland	795 .197	820.320	849.571	819.863	850.910	925.222	1.028.472
Italy	11.168.200	11.262.000	11.367.000	11.536.525	11.989.400	11.952.800	12.219.550
Latvia					236.600	263.833	306.838
Lithuania					233.950	264.016	283.672
Luxembourg	79.701	79.440	84.952	87.739	93.312	98.832	105.070
Malta							43.568
Netherlands	2.903.000	2.984.000	3.117.000	3.394.000	3.214.000	3.349.000	3.445.000
Poland					3.413.000	3.509.005	3.654.700
Portugal	1.248.259	1.285.418	1.298.269	1.406.267	1.430.266	1.498.121	1.732.815
Romania						1.140.844	1.309.381
Slovakia				413.253	370.387	346.700	300.515
Slovenia					161.507	168.630	204.182
Spain	6.628.035	5.950.509	6.374.074	7.375.134	7.443.710	7.798.421	8.006.787
Sweden	976.800	1.010.154	1.029.386	1.422.621	1.479.537	1.512.080	1.419.862
United Kingdom	9.179.981	9.313.900	9.897.255	10.059.371	10.230.001	10.280.196	10.471.264
European Union							
EU15	65.494.821	64.875.949	66.579.123	69.271.397	70.001.120	70.749.779	72.765.345
EU25					76.283.972	77.262.708	79.557.645
EU27						78.923.744	81.297.506

Data on production of manufactured goods are sums from the quantities reported by each Member State in PRODCOM, as aggregated by EUROSTAT. They are not fit for comparison between Member States. Data in PRODCOM are often inconsistent, mainly due to changing selection of products for which data are available or made public. For the scope of the indicator we need consistent time-series of at least three years. Only consistent time series are used in the indicator. Quantities of exported and imported goods in tonnes are retrieved from the COMEXT database and combined with the PRODCOM data. The quantity of goods put on the market is thus assessed as the quantity of goods manufactured plus the import minus the export, all expressed in tonnes.

Table 65: Assessed quantities of goods put on the market

	assessed tonnes of products on the market						
tonnes	2000	2001	2002	2003	2004	2005	2006
Austria	28.720.412	28.612.511	28.599.247	31.247.825	31.280.080	36.628.855	36.761.021
Belgium		79.793.437	74.208.865	76.492.853	82.346.075	82.544.294	90.878.452
Bulgaria		3.173.344	2.630.399	10.532.535	7.465.353	4.423.830	12.516.589
Cyprus	2.742.108	3.028.423	2.870.930	2.206.650	3.560.080	4.046.556	3.870.685
Czech Rep				8.088.390	13.270.093	8.747.815	13.104.530
Denmark	1.174.080	*4.341.760*	*3.312.422*	*6.014.146*	*2.863.343*	*155.613*	*5.843.365*
Estonia							
Finland	42.529.340	43.374.317	45.908.363	50.154.065	47.985.333	47.279.815	46.047.988
France				246.751.301	277.451.826	263.492.094	264.204.654
Germany	335.655.952	320.493.402	318.019.279	*423.300.812*	*284.326.186*	*440.176.797*	*338.430.261*
Greece		28.551.108	28.561.156	34.037.423	33.799.001	30.843.616	32.155.333
Hungary		17.716.518	20.153.533	24.214.210	24.411.597	23.873.215	20.833.612
Ireland	19.122.183				20.221.605	22.897.548	23.488.811
Italy				325.179.766	342.450.780	328.630.900	336.082.122
Latvia							
Lithuania						*8.760.868*	*9.639.531*
Luxembourg	3.324.365	2.714.688	3.166.952	9.455.498	9.429.524	9.872.801	10.984.004
Malta	1.271.769	1.151.923	1.278.688	1.385.261	1.738.730	1.729.705	1.988.475
Netherlands	81.516.433	56.093.806	67.977.441	77.015.625	67.461.566	93.593.083	101.969.546
Poland					55.684.281	56.533.741	69.078.971
Portugal	42.447.268	43.586.707	43.132.406	37.882.459	38.278.525	37.221.633	32.877.466
Romania	10.425.720	16.504.892	17.590.638	22.112.517	25.156.698		
Slovakia					21.939.661	20.632.541	21.502.035
Slovenia	*4.179.081*	*5.726.151*	5.624.338	6.424.831	7.031.646	*5.386.059*	*5.890.235*
Spain	153.806.790	155.499.360	171.824.169	167.219.039	178.032.954		
Sweden				*6.652.340*	*3.611.317*		
United Kingdom				*76.593.925*	*89.964.958*	*114.488.642*	*131.589.872*
European Union							
EU15	1.789.801.777	1.689.777.860	988.784.926	1.915.337.380	2.036.315.882	2.101.133.843	1.180.855.378
EU25	1.004.784.631	1.013.923.715	1.034.574.475	2.060.920.758	2.237.096.302	2.289.204.118	2.512.501.637
EU27	1.011.385.519	1.024.129.166	1.044.750.491	2.107.444.445	2.286.438.302	2.341.987.129	2.575.769.104

Calculating the ratio of quantity or waste/quantity of product or quantity of waste/GDP gives a value for the need of packaging material to handle the marketed quantity of products. As described above, this value is no indicator that can be used to compare countries, but only to compare the results of one country in a time series. The real indicator is the trend of the line fitted through these values by linear regression. When this line goes up and the trend has a positive value, the quantity of packaging augments compared with the quantity of packed products. This can be interpreted as less compliance with the requirement on prevention over the years. We can only calculate the trend if reliable data for more than three years are available. As the time series for the individual countries are not always equal in length and are not always covering the same years, comparison between Member States is possible but should be done with care. These differences in available time series occur more often when the quantity of products is used as a denominator. When the GDP is used more consistent time series are available.

As an indicator a semi quantitative mark is used as follows:

++	Very positive	Trend value lower than the 20th percentile
+	Positive	Trend value between 20th and 40th percentile
o	Neutral	Trend value between 40th and 60th percentile
-	Negative	Trend value between 60th and 80th percentile
--	Very negative	Trend value above 80th percentile

Table 66: Ratio, trend and indicator for the requirement on prevention, based on the quantity of packaging waste and the quantity of product put on the market

	2000	2001	2002	2003	2004	2005	2006		trend	indicator
Austria	4,07	3,83	3,70	3,71	3,52	3,03	3,17		-0,16	+
Belgium		1,78	2,01	2,12	1,98	2,01	1,83		0,00	-
Bulgaria						11,76	3,44			?
Cyprus					4,07	3,04	1,63		-1,22	++
Czech Rep				8,90	5,85	9,69	6,86		-0,23	+
Denmark										?
Estonia										?
Finland	1,04	1,05	0,98	1,23	1,35	1,46	1,47		0,09	--
France				5,00	4,46	4,69	4,79		-0,04	o
Germany	4,50	4,69	4,85	3,65	5,46	3,51	4,77		-0,03	o
Greece		3,41	3,48	2,98	3,07	3,44	3,28		-0,02	o
Hungary					3,34	3,57	4,25		0,45	--
Ireland					4,21	4,04	4,38		0,09	-
Italy				3,55	3,50	3,64	3,64		0,04	-
Latvia										?
Lithuania						3,01	2,94			?
Luxembourg	2,40	2,93	2,68	0,93	0,99	1,00	0,96		-0,35	++
Malta							2,19			?
Netherlands	3,56	5,32	4,59	4,41	4,76	3,58	3,38		-0,14	+
Poland					6,13	6,21	5,29		-0,42	++
Portugal	2,94	2,95	3,01	3,71	3,74	4,02	5,27		0,35	--
Romania										?
Slovakia					1,69	1,68	1,40		-0,15	+
Slovenia					2,30	3,13	3,47		0,58	--
Spain	4,31	3,83	3,71	4,41	4,18				0,03	-
Sweden				21,39	40,97					?
United Kingdom				13,13	11,37	8,98	7,96		-1,79	++
European Union										
EU15	3,66	3,84	6,73	3,62	3,44	3,37	6,16		0,12	--
EU25					3,41	3,38	3,17		-0,12	+
EU27						3,37	3,16			?

When using GDP other results are obtained. The GDP is generally considered not to be a correct indicator, as it does not refer to the quantity of products being put on the market, but to the price of these products being put on the market. GDP also counts a product only once, when it is sold to the final consumer, and not when it is handled, imported, exported, repacked... A better alternative would be a monetary indicator showing how much both producers and consumers are spending on goods (not services) in real terms. This can be derived from the National Accounts but would require more work.

Only at EU15 level sufficient information is available to assess the compliance with the requirement on prevention. This results in a slightly negative evolution, where more packaging is needed compared to the amount of products. Insecurity exists on the amount of products generated.

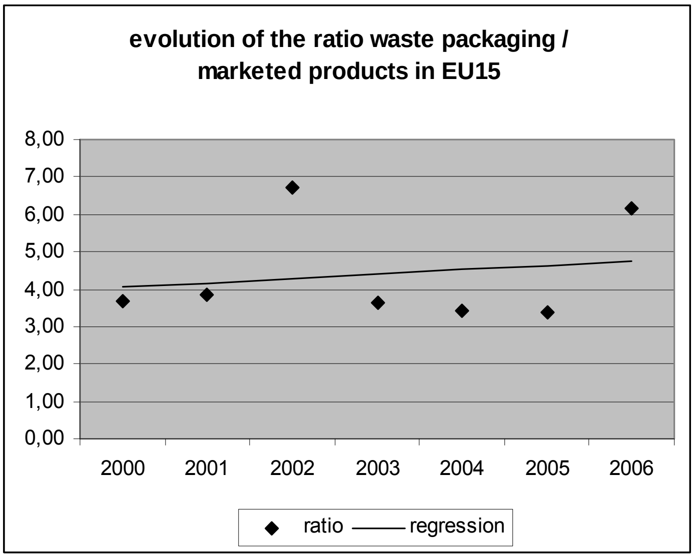

Figure 70: Compliance with the requirement on prevention at the level of EU-15

7.2.2.4 Case "ETC/SCP indicators on packaging waste prevention"

The European Topic Centre on Sustainable Production and Consumption uses the following response indicators to assess the effectiveness of packaging waste management with regard to waste prevention. It is a mix of output and outcome indicators:

- Types of measures that have been implemented, as a typical output indicator;
- (Outcome) indicators of effectiveness:
  - Change in packaging waste generation and GDP (%) - decoupling indicator;
  - Total packaging waste generation (tonnes);
  - Packaging waste generation in kg/inh.year;
- Indicators of cost-effectiveness (outcome):
  - Financing need (EUR/tonne);
  - Revenue from taxes and similar instruments charged on packaging (EUR/capita);
- Other output indicators:
  - Fraction of companies participating in compliance schemes (%).

7.2.3 Decoupling

7.2.3.1 Significance and definition

Special attention is to be paid to the concept of decoupling and to decoupling indicators. Decoupling is an important concept on which attention is paid in article 9, article 29 and in preamble (40) of the Waste Framework Directive: Prevention measures should pursue the objective of *breaking the link between economic growth and the environmental impacts associated with the generation of waste*. The Thematic Strategy states that overall waste volumes are still growing at rates comparable to economic growth. The Commission is required to set decoupling objectives by the end of 2014, and the Member States need to set out decoupling objectives and measures in their prevention programmes.

OECD[74] situates decoupling as follows: The term “decoupling” has often been used to refer to breaking the link between “environmental bads” and “economic goods.” In particular, it refers to the relative growth rates of a pressure on the environment and of an economically relevant variable to which it is causally linked. For example, at the national level, the growth rate of emissions of sulphur dioxide may be compared with the growth rate of GDP; at a sector level, the growth rate of emissions of carbon dioxide from the energy use may be compared to the growth rate of total primary energy supply.

Environmental indicators are often based on the DPSIR framework, which evolved from the OECD Pressure-State-Response (PSR) model. Decoupling indicators describe the relationship between the first two components of the DPSIR model, i.e. a change in environmental pressure as compared to the change in driving force over the same period. Thus, indicators comprising variables belonging to other dimensions of the DPSIR framework (i.e. state, impact or response), are not described as decoupling indicators. From a policy perspective, “pressure” indicators and the decoupling indicators derived from them are attractive because they are apt to change over shorter time periods than “state” indicators under the influence of, for example, environmental or economic policy.

Environmental variables in a decoupling indicator are most often expressed in physical units, and the economic variable either in monetary units at constant base-year prices or in physical volumes. However, the notion of “driving force” suggests that relevant variables may sometimes include others, such as population growth. Population growth becomes relevant when demand for certain environmentally relevant goods or services become saturated at high levels of per capita income. *(like municipal waste generation)*

Much of the evidence presented by the OECD is expressed in terms of changes over time. Decoupling occurs when the growth rate of the environmentally relevant variable is less than that of its economic driving force (e.g. GDP) over a given period. In most cases, however, absolute changes in environmental pressures are of fundamental concern. Hence the importance of distinguishing between absolute and relative decoupling. If GDP displays positive growth, **“absolute decoupling”** is said to occur when the growth rate of the environmentally relevant variable is zero or negative — i.e. pressure on the environment is either stable or falling. **“Relative decoupling”** is said to occur when the growth rate of the environmentally relevant variable is positive, but less than the growth rate of GDP. In the literature, the terms strong and weak are sometimes used as synonyms for absolute and relative, respectively.

OECD states that the term decoupling is not used when the environmental pressure variable increases at a higher rate than the economic driving force. But this is as well a situation where environmental pressure is not coupled to (and thus decoupled from) its economic driving force. We introduce for these cases the term **“negative decoupling”**.

The goal of prevention is not to achieve decoupling. The goal is to achieve sustainability, which means that the environmental pressure drops below a maximum level in absolute terms, to assure that the future environmental quality is safeguarded and the environmental stocks are effectively managed in the long-term, so that the needs of the present are met without compromising the ability of future generations to meet their own needs. However, when an effective prevention policy is implemented, this will first be

[74] OECD Environment Directorate, indicators to measure decoupling of environmental pressure from economic growth (2002)

visible when decoupling occurs. When the distance-to-target is not taken into account, decoupling may be a good indicator for prevention.

7.2.3.2 Visual approach

The most straightforward method to assess decoupling is to present both the waste generation and the economic evolution in a single graph, and to assess on sight if both curves are converging or diverging.

- Disadvantages are that no quantitative value for a decoupling indicator can be shown, which diminishes comparability between analyses, and that no statistical proof can be offered for the presence or absence of decoupling, especially when the graphs or trend lines are submitted to an unknown degree of uncertainty.
- Major advantages are the intuitive presentation form and the easy distinction between relative and absolute decoupling, characteristics that are lacking in the options described below.

As an example the EEA decoupling analysis on packaging waste is represented:

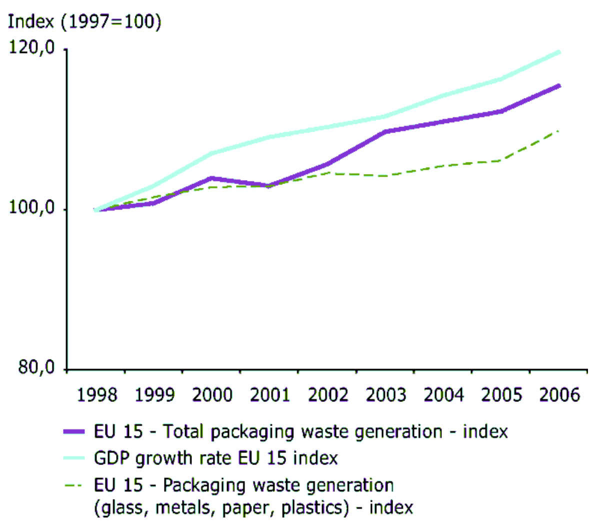

Figure 71: EEA graph on decoupling between packaging waste and GDP

7.2.3.3 OECD-indicator

As an impact indicator, the OECD Working Group on Prevention and Recycling of waste (WGWPR) developed a more quantified strategy to measure decoupling.

A decoupling indicator r(t) for a given year t vis-à-vis a given reference year t_0 is defined as follows:

$$r(t) = 1 - \frac{EP(t) / DF(t)}{EP(t_0) / DF(t_0)}$$

Equation 6: Decoupling indicator basic formula

In this equation EP describes the environmental pressure in year t and DF describes the economic variable (driving force) in year t or t_0. Positive decoupling takes place when the decoupling indicator is greater than zero. There is no decoupling when the latter equals zero (which can be considered a baseline scenario). When the decoupling indicator is below zero, there is negative decoupling.

7.2.3.4 OVAM extension of OECD method

The methodology of OECD is confronted with a set or drawbacks:

- It is sensitive for the choice of year t and year t_0 but it does not take into account the intermediary years. The uncertainty on the data for an individual waste generation year can be relatively high
- It cannot be tested using an hypothesis test

OVAM[75] proposes following changes:

- to replace the numerator and the denominator in the equation by the inclination of a regression line. This offers greater reliability and robustness than the estimate for a separate year.
- To examine the uncertainty intervals on these regression lines, which can be calculated based on the uncertainty interval on the individual annual data.

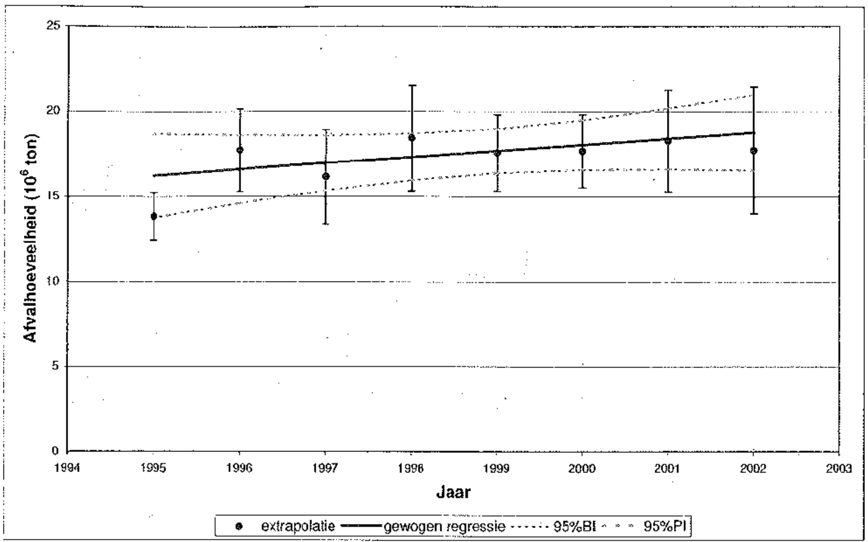

Figure 72: Primary waste generation in Flanders, trend line with its confidence interval

- To set up a hypothesis test to see if the calculated decoupling indicator is above or below the zero value. A value above zero means positive decoupling, but only if the confidence interval of the decoupling indicator is fully above the zero-line decoupling can be assumed with statistical certainty.
- To calculate decoupling indicators for successive time intervals to allow to describe the evolution in the indicator. It should not only be assessed if decoupling has been

[75] OVAM, Indicators for waste-prevention. Development of a methodology for and testing of OECD-indicators (2004)

reached, but also if the relation between waste generation and the economic driver is evolving in the right direction.

Figure 73 shows the decoupling indicators for primary waste. They all are above the zero-line, which would mean positive decoupling, but they are only slightly above the zero-line, and their confidence intervals are overlapping with the zero-line. This means that no positive decoupling can be statistically proven. Figure 74 shows negative decoupling for construction and demolition waste. For the interval 1995-1999 this decoupling can be assured with statistical certainty.

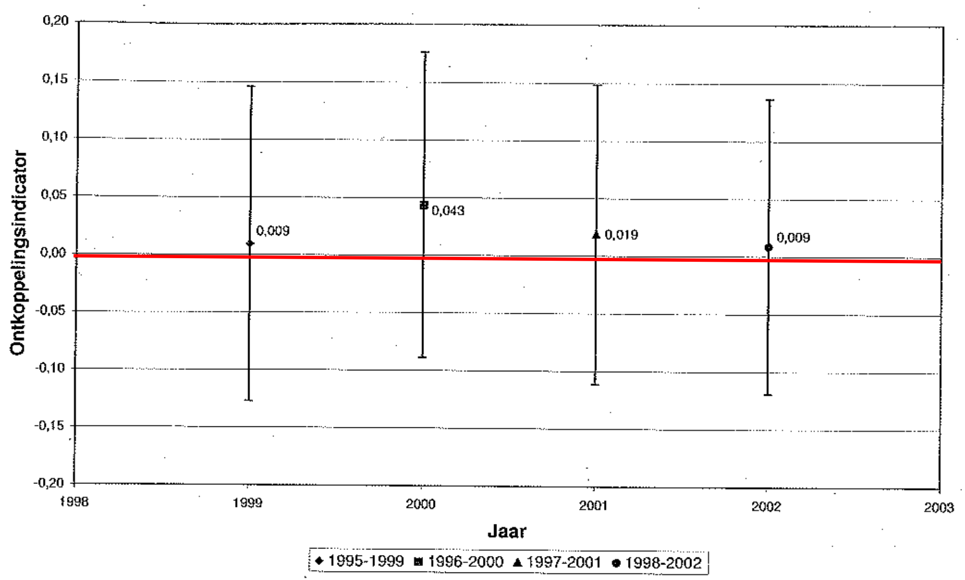

Figure 73: Decoupling indicator for primary waste generation in Flanders

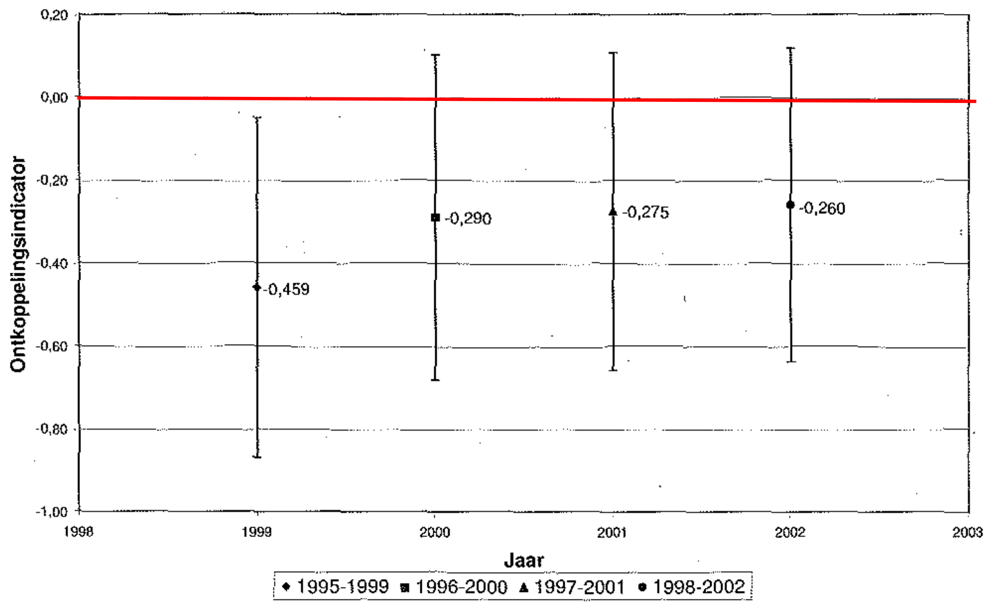

Figure 74: Decoupling indicator for construction and demolition waste in Flanders

Drawback of the OVAM-extension of the OECD approach is that confidence intervals are needed on all yearly data on waste generation, which are only seldom present in Member State waste statistics, and which are lacking for aggregated EU waste statistics.

7.2.3.4.1 Proof of concept

Decoupling is calculated by comparing the regression of the pressure indicator (in this case municipal waste generation in the European Union as assessed by ETC/RWM) with the regressing of an economic indicator (in this case GDP) over the same period. Confidentiality intervals cannot be added due to the lacking confidentiality intervals on the primary data.

Table 67: Calculation decoupling indicator MSW in EU-27

	GDP	MSW kg/inh	% GDP (1995 = 100)	% MSW (1995 = 100)	decouping ind. OECD	m(GDP)	m(MSW)	decoupling ind. OVAM	range
1995	14700	475	100,00	100,00					
1996	15400	486	104,76	102,32					
1997	16200	500	110,20	105,26					
1998	17000	495	115,65	104,21	0,10	5,238095238	1,557895	0,70	1995 - 1998
1999	17800	511	121,09	107,58	0,09	5,442176871	1,473684	0,73	1996 - 1999
2000	19.100	523	129,93	110,11	0,11	6,462585034	1,789474	0,72	1997 - 2000
2001	19.800	521	134,69	109,68	0,10	6,598639456	1,894737	0,71	1998 - 2001
2002	20.500	528	139,46	111,16	0,10	5,986394558	1,031579	0,83	1999 - 2002
2003	20.700	516	140,82	108,63	0,09	3,741496599	-0,29474	1,08	2000 - 2003
2004	21.700	514	147,62	108,21	0,10	4,013605442	-0,69474	1,17	2001 - 2004
2005	22.500	517	153,06	108,84	0,11	4,761904762	-0,73684	1,15	2002 - 2005
2006	23.600	523	160,54	110,11	0,11	6,462585034	0,505263	0,92	2003 - 2006
2007	24.900	522	169,39	109,89	0,11	7,278911565	0,631579	0,91	2004 - 2007

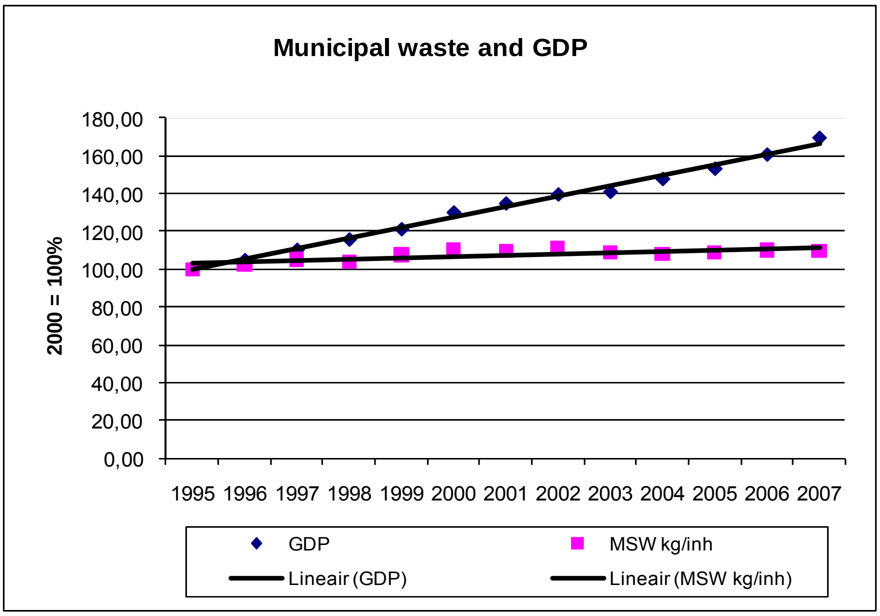

Figure 75: Municipal waste generation and GDP, indicative for decoupling

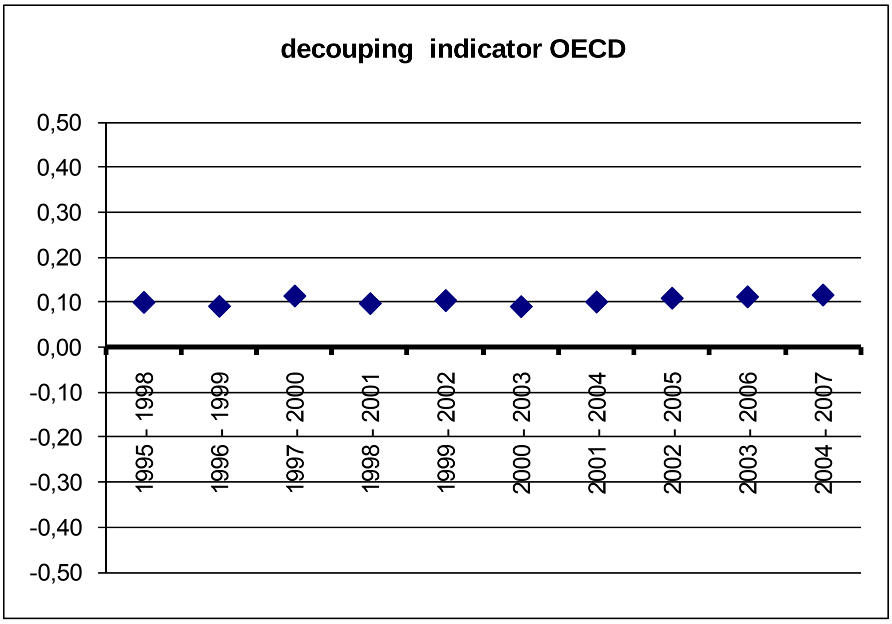

Figure 76: Decoupling indicator for MSW following the OECD approach

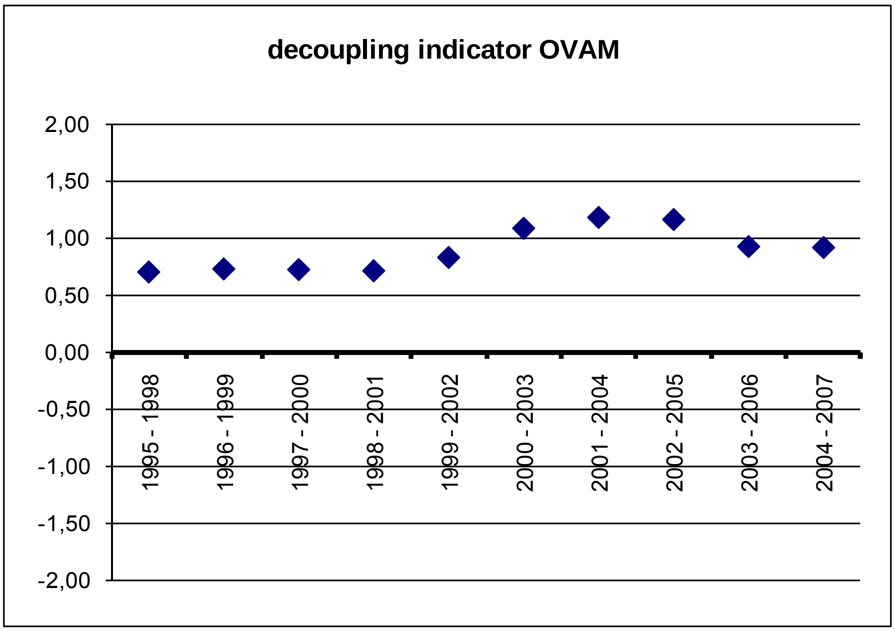

Figure 77: Decoupling indicator for MSW following the OVAM approach

7.3 Mapping of the suitability of indicators

7.3.1 Detailed approach

In this chapter the suitability of the classes of indicators mentioned above is evaluated. A factsheet is developed which contains:

- A short summary of the nature of the indicator
- A description of the possible coverage of the indicator, in terms of prevention policies that can be covered
- An analysis of the effectiveness of the indicator, described as advantages and disadvantages

- A state of affairs on the development and the use of the indicator
- A short assessment of the feasibility, depending on data availability, and the workload and data needed to calculate the indicator

7.3.2 Results

7.3.2.1 Output indicators

Summary	An output indicator is looking directly at the prevention policy measure. It is, unlike an outcome indicator, strictly linked to individual instruments and takes into account the frequency of use of a specific instrument. E.g. number of no-thanks stickers, market share of labelled products, number of reuse shops, awareness of the economy on ecodesign, money spent on subsidies or on green public procurement…	
Coverage	Awareness and education	Can be covered by output indicators, measuring the awareness raising instruments or its impact on the target-groups
	Ecodesign	Difficult to cover with output indicators
	Extended producer responsibility	Easy to cover based on administrative data and reporting obligations in the frame of an EPR scheme
	Green public procurement	Rather easy to cover based on administrative data, requires green accounting
	Labelling / certification	Can be covered by output indicators counting the number, market share… of labelled or certified products
	Marketing	Coverage comparable with awareness and education
	Financial stimuli	Easy to cover based on administrative or (para) fiscal data
	Prevention targets	Requests outcome indicators
	Product standards	Sometimes difficult to cover with output indicators: evaluate the use of non obligatory or even obligatory standards if they are not linked to labelling
	Reuse	Easy to cover based on administrative data or market data, sometimes requires adapted product codes (combined nomenclature or CN-codes) to distinguish from new products.
	Technology standards	See product standards. If product or technology standards are obligatory, the number of infringements can be used as an output indicator.
	Voluntary agreements	Easy to cover based on administrative data.
Effectiveness	Advantages	Output indicators are strictly connected with the measures they are covering, and are necessary to evaluate the instrumental performance of specific measures. They usually are easy to understand and are necessary to follow-up implementation of measures in e.g. waste prevention plans.
	Disadvantages	A general disadvantage of output indicators is that they do not evaluate the effect on waste and material use, see paragraph 7.1.2.

		Because they are so closely connected to the applied instruments, these indicators are difficult to apply or to develop at an EU wide scale. Art 29.2 does not impose MS to apply the prevention initiatives summed up in its annex IV, but asks to evaluate them. This could lead to a more harmonised application of prevention strategies but leaves freedom under the application of the subsidiarity principle to develop own instruments or variants. Each variant requires its own output indicator which cannot always be summed up with indicators in other MS.
State of affairs	Member States have developed several output indicators, often closely linked to waste prevention plans or prevention strategies. OECD did not succeed in developing output indicators at a supranational level.	
Feasibility	Output indicators often use administrative data which are more easily available from processes within the competent authorities' administration. This information has not to be collected de novo but it only requests disclosure and processing to be used as an indicator. A different set of output indicators measures intentions, knowledge, appreciation… and can be realised by surveys	

7.3.2.2 General waste statistics

Summary	General waste statistics in its crude form are used to measure increase or decrease of waste generation. E.g. total generation of waste, household waste generation per capita, packaging put on the market, …	
Coverage	Because it is an outcome indicator, it is difficult to link the indicator results to more specific prevention initiatives. The distinction cannot be made between the result of a specific action and the combined result of a policy mix of actions, economic and demographic evolutions etc… It is not fit to cover awareness and education, ecodesign, extended producer responsibility, green public procurement, labelling / certification, marketing, financial stimuli, product standards, technology standards or voluntary agreements.	
	Prevention targets	The indicator can serve to see if prevention targets have been reached or to measure the distance-to-target. This requests that the targets are defined in line with the available general waste indicators. E.g. no target on bio-waste can be applied as long as an indicator on bio-waste is not well defined in the Waste Statistics Regulation 2150/2002/EC. Similar problems are to be overcome for C&D waste.
	Reuse	Depending on the degree of data available this kind of indicator can be used to measure reuse. E.g. Flanders requests all waste generators to yearly report how the waste has been treated, including the category (preparing for) reuse.
Effectiveness	Advantages	A simple and straightforward indicator based on basic statistics on waste generation. Both the height of the absolute value of the indicator and its evolution in time deliver information. Outcome indicators are necessarily complementary to output indicators
	Disadvantages	On its own outcome indicators are scarcely able to measure the efficiency of individual prevention

		initiatives. They are limited to quantitative waste prevention, which is only a part of the complex issue of waste prevention, and they only focus on the waste phase of a material flow or life cycle.
State of affairs	General waste statistics are defined at an EU-wide level, although still considerable work has to be done to make data reported by different Member States comparable. The major legal instrument for these indicators is the waste Statistics Regulation 2150/2002/EC, next to other reporting obligations in the recycling directives or the Basel Convention. Waste statistics and waste policies (a.o. prevention targets) have to be closely linked. Targets have to be defined in function of available statistics and time series, and statistics have to be defined in line to cover the information needs of waste policies.	
Feasibility	Good, timely and reliable waste statistics request a lot of effort, by the reporting actors, the national authorities and the EU institutions. However these efforts serve multiple goals, among which to give indication for prevention.	

7.3.2.3 MFA derived indicators

Summary	The best indicator that has the closest causal relation with waste generation is considered to be the Domestic Material Consumption (DMC) which is built up from Domestic Extraction (DE) plus Import minus Export. Another possible indicator is Total Material Requirement (TMR)	
Coverage	The coverage is comparable with the general waste statistics mentioned above. It is not useful to follow up individual prevention initiatives but it creates an overview of outcomes or results at an economy wide level.	
Effectiveness	Advantages	The DMC can be used as an alternative for directly measuring waste output. All material entering the economy will leave it by way of waste, sometimes after a short or long time of stock building in the economy. It can count for elsewhere unaccounted waste material flows. A decline in DMC would be indicative for quantitative material use prevention. It takes into account material flows as a whole at a technical level, disregarding sometimes legal but non technical distinctions between wastes and non-wastes
	Disadvantages	The indicators are limited to quantitative waste prevention. No distinction is made between waste and emissions into air, water or soil. It only takes into account material flows leaving the economy, and it is therefore not always the best instrument to measure waste which remains within the economy (because of reuse or of recycling) Although it has a broader scope then mere waste statistics, DMC does not include hidden flows. This can be overcome by the indicator Total Material Requirements (TMR) = Direct Material Inputs plus Unused Domestic Extraction plus Indirect Flows associated to Imports. The level of detail and the applied definitions of materials flows are not always in line with the categories used for waste statistics which makes comparison of both difficult. See paragraph 4.7.2.1
State of	The methodology for MFA is very well developed. Experiments with material flow	

affairs	accounting generate valuable data and insights but they are often confronted with lack of basic data. A harmonised legal frame for MFA, like the frame for waste statistics, does not exist.
Feasibility	MFA fits within the life cycle thinking where material is not only looked at in the waste phase but in its complete material flow throughout the economy. It can be expected that the importance of MFA will be rising in future.

7.3.2.4 Composed complex indicators

Summary	With composed complex indicators all kinds of indicators are covered which can be calculated based on pressures and driving forces, combining for example economic indicators with waste generation or material flow indicators. E.g.: ratio packaging versus packed product, resource productivity (=GDP/DMI)…	
Coverage	These indicators are mainly outcome indicators. However they can be tailored to serve a very specific goal. In paragraph 7.2.2.3 an indicator is described to measure the first essential requirement in the Packaging and Packaging Waste Directive. As it is an outcome indicator it does not measure the effects of policy instruments to implement this essential requirement, but it assesses if the goal of this requirement is being met: limiting the amount of packaging compared with the amount of packed product. Complex indicators could be developed combining output and outcome indicators e.g. to see if rising awareness of consumers leads to less post-consumer waste generation.	
Effectiveness	Advantages	The indicators can be designed to serve specific policy questions and can give balanced and substantiated answers to rather specific information needs.
	Disadvantages	Complex indicators are multi-source indicators. The quality and reliability of the indicator depends on the quality and reliability or several independently collected basic data sets and on the often limited possibility to combine these data. Important data sets like PRODCOM often are incomplete or confidential. GDP is often used as a composing element of complex indicators, but economic indicators such as GDP were never designed to be comprehensive measures of well-being. Complementary indicators are needed that are but more inclusive of other dimensions of progress – in particular environmental and social aspects. The Communication "GDP and beyond, measuring progress in a changing world"[76] offers a first step in a roadmap to better indicators. Although complex indicators can give more specific outcomes, due to the available datasets they are frequently limited to quantitative waste prevention.
State of affairs	While some complex indicators, like resource productivity, are conceptually well established and are used as a MFA indicator (see above) other still are in the phase of development or experiment.	
Feasibility	A complex indicator is always a derived indicator. No supplementary data gathering is needed but quite some efforts on comparability are needed. The use of international standards (like NACE codes for industrial sectors or HS/CN codes for products) can help to design further complex indicators.	

[76] COM(2009) 433 final , Communication from the Commission to the Council and the European Parliament, GDP and beyond, measuring progress in a changing world, Brussels, 20.8.2009

7.3.2.5 Decoupling indicators

Summary	A decoupling indicator is a specific form of a composed complex indicator. It always combines a driving force with a pressure. As driving forces can serve: economic parameters, but also demography or other societal aspects. Possible pressures include all quantifiable environmental pressures, not limited to waste generation or material use. E.g. decoupling from CO2 emissions from energy use, decoupling of waste generation from economic growth, decoupling of total use of hazardous substances from turnover of EEE, …	
Coverage	Decoupling is an outcome indicator with all properties of a composed complex indicator, as described above. Art. 29.2 second sentence of the Waste Framework Directive describes decoupling as breaking the link between economic growth and the environmental impacts associated with the generation of waste. It is thus not limited to waste generation (quantitative prevention) but to environmental impact reduction associated with it which includes qualitative prevention.	
Effectiveness	Advantages	It can be used to measure all kinds of waste or material use prevention, and is not limited to straightforward quantitative prevention of waste generation. It leads to a value above or below zero, which is easy to understand. Trends in this value can illustrate the tendency towards more or less decoupling. It can easily be illustrated in a graphical way.
	Disadvantages	It is not an indicator for prevention, but an indicator for what probably will be an observable effect of prevention. Decoupling does not mean that prevention takes place, but a first effect of effective prevention could be found in decoupling. It is limited to environmental pressures[77] that can be expressed market wide in a quantitative way. The calculated value above or below zero indicator give a value which does not include scientific or statistical surety about the occurrence of decoupling.
State of affairs	The concept has been studied in detail by OECD, and has been applied on a set of environmental pressures. For waste it is usually limited to calculating decoupling between plain quantitative waste generation and economic growth. The methodology on calculating decoupling still needs refining and adaptation to the available data. It can only be applied when sufficient long time series exist. This is possible for average municipal waste generation, but it is not possible for e.g. total industrial waste generation. For the latter data on only two reference years (2004 and 2006) is available.	
Feasibility	A calculated decoupling indicator is needed to objectivise and substantiate claims on decoupling. Only when waste data are provided with confidence intervals or CoV a statistical test can be performed to proof decoupling. Neither the Waste Statistics Regulation in its actual form nor the data collection systems in most of the Member States are actually capable of providing this information. The method is limited to quantitative information, which de facto limits the method to evaluating quantitative prevention. If quantitative data on hazards or presence of hazardous substances in waste becomes available, also qualitative waste prevention could be tested by a decoupling indicator.	

[77] Although the Waste Framework Directive uses the word ‘impacts’, ‘pressures’ could be a better wording, in line with the DPSIR frame and with the definition of decoupling by OECD.

7.4 Proposal of headline indicators

7.4.1 Characteristics

A headline indicator is a suitable indicator, not for a specific policy instrument or a specific waste stream or sector, but for a global policy evaluation. It will be used at a high level of policy making, but also as a tool for communication or awareness raising. For this goal a headline indicator should possess following properties:

- It is robust, which means that he will not evolve as an effect of variations of or statistical uncertainty on the basic data
- It is representative. It either aggregates data for the total situation, or it gives a representative "pars pro toto" for this situation.
- Time series can be made from it. The underlying data are consistently available over time
- It is as much as possible self-explaining, which makes it fir for communication or for policy developing. It can easily be interpreted by laymen in the field of waste statistics.

Furthermore is should possess all characteristics of any good indicator, as described in paragraph 7.1.3:

- It is pertinent, giving answers to the right questions;
- Sufficient rough data or information are available as raw material to construct the indicator;
- It is usable for different countries and markets or material and waste streams or industrial sectors;
- It is or can become popular in use;
- It is compatible with Community data;
- It has proven maturity, quality and support;
- It is scientific and statistic reliable and has credibility.

7.4.2 Limitations of the policy advice

Article 9 of the Waste Framework Directive provides for a roadmap for an evaluation process on EU wide waste prevention objectives. Its target is: *"By the end of 2014, the setting of waste prevention and decoupling objectives for 2020, based on best available practices"*. Of course the development of objectives and of indicators to measure the distance-to-target for these objectives have to go hand in hand. But the development of possible objectives makes no part of this study. The indicators proposed below and in chapter 7.5 do not prefigure these objectives and may therefore need re-evaluation and refining.

The indicators drafts are based on more or less readily available data and therefore are limited in there capacity to cover all environmental impact or resource use aspects of waste prevention policies. They are limited to output indicators that could cover quantitative and qualitative aspects, and to outcome indicators that are largely limited to mere quantitative waste prevention.

7.4.3 Headline output indicator

Output indicators are usually not fit to be used as a headline indicator because they are too much linked to individual instruments which can differ from Member State to Member State. One overarching major output indicator can be based on the reporting from article 37 of the Waste Framework Directive. Member States have to report once every three year on a.o. the progress achieved in the implementation of the waste prevention programmes. The report shall be drawn up on the basis of a questionnaire or outline established by the Commission.

The questionnaire to be developed can be the basis for standardised building blocks for an EU-wide waste prevention output indicator. It could provide answers to the questions:

- Do the Member States comply with the obligation of art. 29 to establish waste prevention planning. Based on article 33 the plans themselves are reported and can be evaluated on compliancy with the Waste Framework Directive and e.g. art. 29.
- Do the Member States reach the waste prevention objectives they have imposed on themselves. Of course a yes-no answer on this question does not make any statements on the quality and the level of ambition of these self-imposed objectives and the benchmarks used.
- To what degree do the proposed measures in the nationals waste prevention programmes conform to internationally identified best practices.

Because of the nature of output indicators and of the approach through questionnaires and judgement of nationals waste preventions plans, this indicator will be based upon expert judgement and evaluation, possibly using a scoring system. It therefore will not always have the requested characteristics of simplicity, transparency or robustness.

In order to develop such a standardised output indicator both the questionnaire, as mentioned in article 37.2 and the way to evaluate the results of the questionnaire, have to be agreed upon in Comitology procedure.

7.4.4 Headline outcome indicator

Because of the shift from mere waste policy to life cycle thinking it is important that a future outcome indicator takes into account all phases of a material flow and not only the waste phase. It could therefore be advised to complement the main waste generation indicators with a MFA based indicator.

Because of the impact of hidden flows, especially in the phase of raw material extraction situated largely in non EU-countries, and because of the increasing global character of environmental impact and resource use, the indicator Total Material Requirement (TMR) can be proposed. It includes:

- Domestic Extraction
- Plus Import
- Minus Export
- Plus Unused Domestic Extraction
- Plus Indirect Flows associated to Imports.

Because the mere sum of these parameters does not carry sufficient information to base a policy on it, it could be used as a part of a complex indicator. The ratio **GDP/TMR** could express the degree in which the development of our economy depends upon the use of materials and the environmental impacts and resource depletion effects that could depend from the quantity of material used.

Drawbacks for this indicator are:

- It only focuses on quantities of materials, and not on the actual environmental effects of the kind of use of these materials
- Indirect flows are not easy to measure
- GDP is an imperfect indicator for economic development as it disregards important societal effects.
- Its quality depends on the availability of reliable and accessible data in e.g. PRODCOM and COMEXT

Nevertheless, we still like to propose the use of this indicator because of its advantages:

- It takes into account material flows at the whole of its life cycle
- Data at product level are available or may be made available
- It does not disregard the important impacts of hidden flows
- It can be easily made understandable as an indicator to measure if the economy uses materials efficiently
- It can be complemented with waste statistics
- Although it is not perfect, it is in a way the best we can get.

An alternative headline outcome indicator is the decoupling indicator as described in paragraph 7.5

7.5 Proposal of an indicator complying with Art. 29.4

Point 4 of article 29 introduced the possibility to develop indicators for waste prevention measures under comitology procedure at an EU-wide level. This would enhance comparability of data, targets and policy assessment. The concept of decoupling is mentioned very explicitly in article 29 and in other places of the Framework Directive.

When developing an indicator for decoupling two major aspects have to be taken into account:

- Decoupling is not an indicator for prevention. It is also not the final scope of prevention. When decoupling can be observed, this does not mean automatically that prevention has been effective. However when prevention is effective, it will most probably lead to an observable form of decoupling. When relative or even absolute decoupling has been reached, prevention efforts still have to be continued, because the final scope of prevention is to reach a stage where the environmental pressure is limited below an absolute value which allows for sustainability.

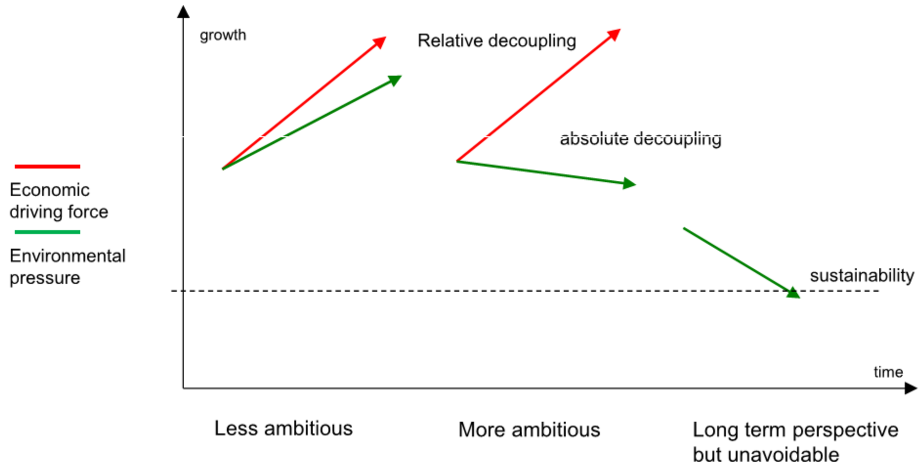

Figure 78: Decoupling and sustainability

- Decoupling as described in article 29.2 aims at breaking the link between economic growth and the environmental impacts associated with the generation of waste. This supposes an association between the generation of waste and the environmental impact of waste. It does not describe how this association looks like. It could be a straightforward linear association and in this case decoupling could be read as a plain decoupling between the economic growth and the generation of waste. The association could however be of a more complex nature. Some waste prevention actions, in casu qualitative waste prevention, work specifically on dissociating this association between waste generation and the environmental impact of it, e.g. by avoiding hazardous substances. For these waste prevention action decoupling is not the most fit indicator.

The decoupling indicator we propose is based upon the ratio between the growth rate of the environmental pressure and the growth rate of the economic driving force, for values of the five preceding years.

$$r_{y-5\rightarrow y} = 1 - \frac{b(EP)_{y-5\rightarrow y}}{b(DF)_{y-5\rightarrow y}}$$

Equation 7: Decoupling indicator, adapted formula

With

- $r_{y-5\rightarrow y}$ = the decoupling indicator for a time interval of five years from y-5 to y
- b(EP) $_{y-5\rightarrow y}$ = the slope of the linear regression of the environmental pressure (e.g. the waste generation) over the last five years
- b(DF) $_{y-5\rightarrow y}$ = the slope of the linear regression of the economic driving force (e.g. the GDP) over the last five years

Because of easy access to basic data, we propose:

- EP is defined as total waste generation, possibly split up in the categories of waste or the categories of industrial activities as used in annex I and II of the Waste Statistics Regulation
- DF is defined as GDP, if available GVA for specific sectors could be used as well

Alternative data for EP or DF can be included in the formula, based on the data needs and the possibly defined objectives.

The indicator is a value above or below zero.

- A positive value indicates possible positive decoupling.
- A negative value indicates possible negative decoupling
- The distance to zero indicates the distance from a situation of perfect coupling[78]
- If the value $b(EP)_{y-5 \rightarrow y}$ is negative itself, absolute decoupling can occur.

We have to take into account that the formula as described above is not a simple relation between waste generation and GDP. It is the explicit intention of the regulator to have a more balanced and comprehensive indicator taking into account more aspects than merely the quantity of waste being generated. As illustrated in detail above the scope of waste prevention is much more differentiated, aiming, as described in article 29 of the Waste Framework Directive, to break the link between economic growth and the environmental impacts associated with the generation of waste. The formula above is applicable on all environmental impacts that are quantifiable, like resource depletion, land use, health impacts, degrees of self sufficiency, concentrations of hazardous substances, greenhouse gas emissions etc…

7.6 Conclusion – a set of indicators

The legal background for the use of prevention indicators is included in articles 9 and 29 of the waste framework Directive.

- Article 29.3 states that “Member States shall determine appropriate specific qualitative or quantitative benchmarks for waste prevention measures adopted in order to monitor and assess the progress of the measures and may determine specific qualitative or quantitative targets and indicators, other than those referred to in paragraph 4, for the same purpose.”
- Article 29.4 states that “Indicators for waste prevention measures may be adopted in accordance with (comitology procedures)”
- Article 9 states that Commission shall submit to the European Parliament and the Council reports and proposals for measures to support prevention activities and the implementation of the waste prevention programmes. By the end of 2014 waste prevention and decoupling objectives have to be set for 2020.

[78] Only if the coefficient of variation on the basic data for the individual years is known, a confidence interval for the indicator can be calculated and positive or negative decoupling can be statistically proved.

This chapter 7 offers the scientific background to develop indicators fit for developing and measuring targets in waste prevention plans, for communicating prevention results and for the setting of waste prevention and decoupling objectives.

One single indicator will not suffice to serve these multiple goals. A basket of complementary indicators will be needed.

- To formalise and make measurable the concept of decoupling an indicator as in paragraph 7.5 and a standardised scientific method has to be decided upon.
- Complementary to this calculation method, indicators have to be selected to describe correctly the environmental pressure for which decoupling will be examined. The above mentioned general waste statistics may serve this goal, as well as complex indicators describing in more detail qualitative or quantitative aspects. E.g.; the degree of compliancy with the essential requirements on packaging waste could be such an indicator. Indicators can be developed for different waste streams, material types, environmental effects…
- Because decoupling is one of the possible effects of prevention, but it is not the end-point of prevention, more general complementary outcome indicators have to be used. TMR can be proposed.
- Finally it has been substantiated that output and outcome indicators have to be used in parallel, because the cause-effect relationship between prevention measures and environmental effects is sometimes complicated and not easy to measure directly. A complementary output indicator can be based upon quality control parameters for the development and the implementation of the waste prevention plans.

8 Conclusions

8.1 Scoping waste prevention

The scope of waste prevention is analysed through literature research and stakeholder consultation, which lead to an overview of key characteristics:

- The actual definition of waste prevention still serves its purpose and can be condensed to two main aspects: prevention of waste generation (quantitative prevention), and prevention of harm through waste (harm prevention).
- Quantitative prevention and harm prevention are to be combined; both aspects are not exclusive but rather supportive of each other.
- Waste prevention in the design phase is the more effective. The higher stage in the material chain of life cycle the prevention measures are taken, the more effect they have on all subsequent stages.
- Prevention through design takes place before the material flow starts, in the phase where decisions of a strategic or technical nature are taken. It includes commercial strategy development, market positioning, spatial planning, dematerialization etc.
- Waste prevention cannot be defined by referring to a kind of policy instrument. Based on the DPSIR model, prevention is a policy response interacting with mainly driving forces and pressures.
- The distinction between *reuse* and *preparing-for-reuse* is merely of a legal, and not of a technical or environmental nature. If performed on waste, the measures are defined as 'preparing-for-reuse'; if performed on a non-waste, the same measures are 'reuse'.
- Reuse is waste prevention, because it temporarily prevents that a material or product enters the waste phase, but also because it reduces the quantity of products entering the waste phase, especially in a replacement market.
- Reuse can lead to perverse effects when combined with export to non-OECD countries with poor waste treatment possibilities. Qualitative prevention can be the key to the solution.
- Recycling and prevention are connected, but request a different approach. Design for recycling does not equal design for longevity. However, recycling leads to quantitative prevention as a side effect.
- Broadening the scope of waste prevention to environmental harm prevention defines "Activities to provide outright avoidance of environmental and resource depletion impact and means to minimize environmental and resource depletion impact".
- There is no natural hierarchy between different waste prevention measures. LCA is needed to define appropriate priorities in a case-by-case situation. However, life cycle thinking and life cycle analysis may not be used to dilute waste prevention actions as LCA does not integrate prevention criteria. However LCA can highlight where waste prevention measures could pose a risk of actually increasing environmental impacts, rather than reducing them.
- Life cycle thinking may request an alternative material treatment hierarchy: (1) dematerialised services, (2) full cradle to cradle approach, (3) services with input from renewable resources – a cyclic reuse phase – a waste disposal output, (4) services with input from non renewable resources – a cyclic reuse phase – a waste disposal output, and (5) Services with input from non reusable resources – a waste disposal output.

A visual map for waste prevention strategies has been developed, complemented with fact sheets on instrumental issues and life cycle steps. The instruments include:

- awareness and education
- ecodesign
- extended producer responsibility
- green public procurement
- labelling / certification
- marketing
- positive and negative financial stimuli
- prevention targets
- product standards
- reuse
- technology standards
- voluntary agreements

The identified life cycle stages are: design, extraction, production, distribution, use, waste, and end-of-waste.

8.2 Material flows and their impacts in the economy

Based on the available data, a quantitative description is given of the current EU situation and near future development regarding waste and material generation and prevention. Key environmental impacts for selected material flows are mapped out.

In the main document a detailed estimate has been made of the amounts of data already available, in close consultation with EUROSTAT and the EEA. The main waste data source is EUROSTAT's data centre on waste, complemented by waste fact sheets and by studies on specific waste streams prepared by the EEA and the ETC-RWM. With respect to material inputs, EUROSTAT has collected a set of partly reported partly estimated data on the consumption of approximately 50 material types for the EU Member States in the period 2000 to 2005.

The future trends assessment concludes that the total generation of MSW will increase slowly, driven by both demographic and economic changes. Landfill will drop, incineration will rise and stabilise, recycling of MSW fractions tends to stabilise after a short period of continued increase, composting tends to increase considerable, and AD becomes more important as a source of green energy. Industrial and other non-household waste streams have the tendency to increase. Inert waste becomes more and more visible. Export of waste to non-EU-27 countries keeps increasing.

The EUROSTAT Questionnaire on Economy wide material flow accounts (EW MFA) from 04.02.2009 does not differentiate between products or wastes being imported or exported. However, only if less than 0,34% of the total amount of recycled waste would be recycled outside the EU there would not be a material leakage. The figures, even incomplete, show a considerable risk of material leakage through waste shipment. However, for now, this is largely compensated by the much higher imports of materials as products / raw materials compared to the exports of mainly products. Material shortages through waste shipments will not occur at a general level, but may be problematic for specific rare material types.

From the entering material streams approximately 40% leaves the economy as waste in the same year. From this waste stream again 40% flows back to the economy to be recovered as a material or a fuel. There is more stock in landfill than in existing products in use for most materials except for metals. The minerals in stock are by far the most important volume in tons both in products in use (95 %) and landfill (75 %). Biomass evidently is an important yearly material input stream, but hardly contributes to stock building (only some wood and paper).

The analysis on the environmental impacts of consumption and production concludes:

- Minerals contribute very strongly to consumption by mass;
- Crude oil, coal, natural gas, plastics but also animal products and crops are of the most importance regarding global warming;
- Animal products and crops dominate land use competition;
- Plastics, metals, crude oil and coal have the largest impact on human toxicology.

When aggregating these findings, animal products, crops, coal, plastic and crude oil appear to be the main contributors to environmental impacts.

8.3 Measuring waste prevention potential and impact

The list of material and waste streams for which the potential is examined included mineral, wood, bio-waste, plastics, paper and cardboard, glass, metals, hazardous material and waste, and MSW. The selection is partly inspired by data availability and covers over 80% of all waste generated in the EU.

Four life cycle impact indicators, for which sufficient data were available, were evaluated for the environmental impact of the 10 waste streams mentioned above: greenhouse gasses emissions, resource depletion, acidification potential and eutrophication potential.

8.4 Identification of areas for intervention

A multi criteria analysis has been used to identify the areas presenting the highest potential for waste prevention. Two fundamental questions have to be solved to identify these areas:

- What are the most promising material flows?
- What are the most promising prevention strategies to apply on these waste streams?

This information obtained has to be checked with a third question; which policy strategies are compatible, or can überhaupt be combined with a given material or waste stream.

For each material flow three sets of independent evaluation questions have been answered: the potential for quantitative prevention, the potential for qualitative prevention and life cycle aspects. For each strategy, four sets of independent evaluation questions have been answered: on efficiency, on feasibility, on life cycle phase and on societal aspects.

The results of the MCA indicate that hazardous waste and metal waste are the high potential areas for waste prevention, because of their high environmental impact and large amount of hidden flows. The most promising strategies for reducing both hazardous and metal waste would be ecodesign and product standards.

REACH is an important instrument when trying to achieve effective waste prevention on hazardous waste, because it can play its full role in the post-waste lifecycle stages of a product. REACH can enhance qualitative prevention of the use of hazardous products that can end up in the waste phase, by excluding the use of certain substances, or by sharing information and thus sensitising the designer to use alternatives. And REACH plays a role in harm prevention when handling the waste fractions, because the exposure scenarios to be developed include the waste phase as an integrated part of the life cycle.

Quantitative effects of waste prevention measures assess a decreasing average and total generation of waste in 2020, compared to the baseline scenario. But compared to the actual situation assessed for 2010, both average and total waste still tend to increase.

8.5 Initial catalogue of indicators to measure and describe waste prevention

The effectiveness of prevention measures is very difficult to assess. Prevention is very hard to monitor directly, as it often adds up to “measuring what is not there”. To measure quantitative waste prevention is to measure a non-existent amount of waste. To measure qualitative waste prevention is to measure harm that did not occur.

Two different strategies are a direct assessment of e.g. the size or degree of participation on specific response actions (output indicators), or an indirect assessment of the results of the action on pressure and state (outcome indicators).

- Output indicators are looking directly at the prevention policy measure. It is, unlike an outcome indicator, strictly linked to individual instruments and takes into account the frequency of use of a specific instrument.
- General waste statistics in its crude form are outcome indicators used to measure increase or decrease of waste generation. They are usually simple and straightforward indicators based on basic statistics on waste generation. Both the height of the absolute value of the indicator and its evolution in time deliver information.
- Material flow accounting derived indicators with the closest causal relation with waste generation are the Domestic Material Consumption (DMC) and the Total Material Requirement (TMR).
- With composed complex indicators all kinds of indicators are covered which can be calculated based on pressures and driving forces, combining for example economic indicators with waste generation or material flow indicators. They can be tailored to serve a very specific goal. A disadvantage is that complex indicators are multi-source indicators.

Decoupling is an important concept of the Waste Framework Directive: prevention measures should pursue the objective of breaking the link between economic growth and the environmental impacts associated with the generation of waste. Decoupling refers to breaking the link between “environmental bads” and “economic goods”. A decoupling indicator is a specific form of a composed complex indicator, combining a driving force with a pressure. Economic parameters, but also demographic or other societal aspects can serve as driving forces. Possible pressures include all quantifiable environmental pressures, not limited to waste generation or material use.

A headline indicator is a suitable indicator, not for a specific policy instrument or a specific waste stream or sector, but for a global policy evaluation. It will be used at a high level of policy making, but also as a tool for communication or awareness raising. It should be robust, representative, it should allow time series and it has to be self-explaining. Furthermore it should possess all characteristics of any good indicator: pertinence, data should be available, usable in different contexts, popular, compatible with Community data, mature, reliable and credible.

A formula and a calculation method for a decoupling indicator have been proposed. We have to take into account that it is not a simple relation between waste generation and GDP. It is the explicit intention of the regulator to have a more balanced and comprehensive indicator taking into account more aspects than merely the quantity of waste being generated. The formula is applicable on all environmental impacts that are quantifiable, like resource depletion, land use, health impacts, degrees of self sufficiency, concentrations of hazardous substances etc…

Because one single indicator will not suffice to serve multiple goals, a basket of complementary indicators will be needed. If may consist of following four elements: indicators for decoupling, indicators for environmental pressure, general policy outcome indicators and general policy output indicators:

- To measure decoupling, an indicator and a standardised scientific method are proposed.
- Indicators have to describe correctly the environmental pressure for which decoupling will be examined. The general waste statistics may serve this goal, but this is not sufficient. Complex indicators describing in more detail qualitative or quantitative aspects are needed.
- Because decoupling is one of the possible effects of prevention, but it is not the end-point or goal of prevention, more general complementary outcome indicators have to be used. TMR is proposed as a headline indicator.
- Finally output and outcome indicators have to be used in parallel. A complementary output indicator can be based upon quality control parameters for the development and the implementation of the waste prevention plans.

Annex 1: Discussion topics and feedback by stakeholders

Introduction

Article 9 of the new Waste Framework Directive states that by the end of 2011 the Commission has to prepare an interim report on a.o. the scope of waste prevention. This report has to be submitted to the European Parliament following the consultation of stakeholders.

In the frame of this exercise ARCADIS Belgium and partners are preparing an "Analysis of the evolution of waste reduction and the scope of waste prevention". This is performed within the Framework contract ENV.G.4/FRA/2008/0112 with Bio-Intelligence.

To this aim an analysis has been made on:

- The concept and legal definitions of waste prevention and reuse in the Waste Framework Directive, the Packaging and Packaging waste Directive, the ELV Directive, the WEEE Directive, the Ecodesign Directive on EuP, the existing thematic strategy on waste prevention and recycling, the definitions in the EEA ETC/SCP, the Basel Convention, the results of the OECD WGWPR, and definitions and concepts in Finland, France, Ireland, the Netherlands and Sweden.

Furthermore following topics have been analysed:

- The position of waste prevention in the DPSIR cycle, the material flow chain and the instrumental characteristics
- The relation between reuse and prevention
- Trade off between qualitative and quantitative prevention
- The relation between recycling and prevention
- A waste prevention taxonomy

We like to share with you two preliminary results of our analysis until now, and would appreciate any comments, additions or remarks on:

- A draft set of characteristics of waste prevention.
- A visual map ordering waste prevention strategies, completed with factsheets

Could you please send us your remarks before Friday 19th of February to d.vandenbroucke@arcadisbelgium.be

General remarks

EUROPEN

As a pan European industry and trade organization EUROPEN confines its activities to issues related to packaging and the environment. Accordingly, our response is limited to references to packaging in the draft documents and we offer no opinion on other elements they contain.

We note that the project is linked to the EU Waste Framework Directive 2008/98/EC, Article 9, dealing with potential waste prevention and possible development of waste prevention indicators. However, regulation of the environmental characteristics of packaging and packaging waste in the EU is the subject of a different Directive, 94/62/EC on Packaging and Packaging Waste. The Packaging and Packaging Waste Directive is lex specialis to the Waste Framework Directive, meaning that it takes precedence over the Waste Framework Directive where packaging and packaging waste are concerned. This has been confirmed by the European Commission in its recent Communication on beverage packaging. Therefore, when addressing packaging in the draft documents sent to us, the definitions and requirement of Directive 94/62/EC should be the point of reference, not the Waste Framework Directive. Unlike the Waste Framework Directive, which has the environmental Articles of the Treaty as its legal base, the Packaging and Packaging Waste Directive has the EU internal market Treaty Articles as its legal base, hence the aim and objective of these two Directives is not the same. The Packaging and Packaging Wastes Directive defines minimum Essential Requirements for packaging which are supported by harmonised EU standards developed by CEN under an EU Commission mandate.

EUROSTAT

As data centre on waste (www.ec.europa.eu/eurostat/waste) we are we are collecting, processing, validating and making available data on the generation and treatment of waste from Members States, for various waste streams and by economic activities.

This data is official statistics on the one hand and data to be reported in the frame of the implementation of various legal acts on waste on the other. We are still very busy with the improvement of the knowledge on waste - and have so far not had capacities to invest in studies on waste prevention concepts.

Waste prevention we also find difficult to measure, so at the time being the EUROSTAT waste team has little to contribute, just that the characteristics for prevention you have put together in your papers are all reasonable for me. I would probably not be so rigid with qualitative prevention: In analogy with my experience from risk assessment of chemicals I would say that qualitative prevention has its role, when it is just not possible in a certain process (which generates an added - not necessary monetary - value for the society) or is economically not affordable/cost effective.

Municipal Waste Europe

What is waste generation?

The reader of the documents will need further guidance to the very important difference between prevention of waste and prevention of waste being generated. The first is traditionally seen as "preparing for re-use" or other lower steps in the waste hierarchy. It is not seen as a part of prevention actions (as waste has already been generated) but rather as a part of waste treatment. Prevention of waste being generated is not a target of the waste management or waste treatment sector generally. Some actions will however affect or naturally be carried out by the waste sector.

The ARCADIS documents combine both concepts. The life cycle fact sheets states the difference but does not provide clear guidance. The Guidance to the Analysis mixes the both and even if the problem is addressed, no clear guidance is provided. The Visual map includes references to instruments addressing the quality rather than the quantity of the waste.

What is prevention?

The main question for the analysis is clearly to establish is prevention is to be measured in Quantitative or Qualitative terms. The Quantitative prevention idea appears to mean that all waste is to be prevented equally. This idea is more vaguely described but the prevention focuses on the targets and is always relative to the impact.

The ARCADIS documents seem both to know the difference and to ask for clarification while asking for comments supporting one or the other as the primary target.

The Commission Guidelines for Waste Prevention does not include either concept and it is not clear why the analysis for 2011, is concentrating on them.

Position 1

Waste prevention should be of secondary importance compared with diminishing environmental and human health impact and saving resources in the whole life cycle of products.

The French national waste prevention programme mentions: *Prevention measures can address all upstream stages of the product life cycle before wastes are collected by an operator or local authorities, starting from the raw materials extraction phase until reuse.*

The Irish EPA Waste Prevention Plan mentions: *Elimination or reduction at source of (1) materials, water and energy consumption, (2) waste arisings (solid, liquid, gaseous and heat) (3) hazardous or harmful substances.*

On many more occasions the concept of waste prevention is expanded or replaced by a concept focussing on preventing resource use or environmental impact throughout the whole life cycle of a material.

This approach would be in line with article 4 point 2 of the Waste Framework Directive, where Member States shall take measures to encourage the options that deliver the best overall environmental outcome, justified by life-cycle thinking on the overall impacts of the generation and management of such waste.

This approach would solve discussions on:

- The border line between waste and second hand; e.g. is a second hand (reuse) application in a non-OECD country of old cars or EEE with limited life expectancy better than high quality recycling within the European Union?
- The possible trade off between quantitative and qualitative prevention

Feedback

CEPI

The Position 1 can be agreed to, and could perhaps read also “Waste prevention is a tool in diminishing environmental and human health impact and saving resources in the whole life cycle of products.” Furthermore, it can be agreed that application of the Waste Hierarchy has to follow Article 4(2) rule in seeking the best overall environmental outcome.

The clarification seems to miss the most important starting point, namely the definition given in the Waste Directive (Art 3(13)): Prevention means measures taken before a substance, material or product has become waste, that reduce:

a) the quantity of waste, including through the re-use of products or the extension of the life span of products;

b) the adverse impacts of the generated waste on the environment and human health; or

c) the content of harmful substances in materials and products.

CEPI is of the opinion that prevention measures focussing only on the quantitative measures referred to point (a) may not be measurable, cannot measure the substitution effects on environment and miss an important opportunity of a balanced policy which are offered by using all points (a) to (c) above. It is worth noting that measures in (b) and (c) are easily quantifiable and progress made can be monitored.

Furthermore, the Article 29(2) clarifies “The aim of such [waste prevention] objectives and measures shall be to break the link between economic growth and the environmental impacts associated with the generation of waste.”

This is an important guidance in setting up the priorities in waste prevention, and in weighting the impacts of the alternatives such as “dematerialisation” which is likely to have a significant environmental impact both in energy needs, climate change and in waste generation of the very material infrastructure and technology needed in producing the “dematerialised” services.

EEB

Waste prevention shall not be confused with resources efficiency, as stated several times in the life cycle fact sheet. Waste prevention can contribute to resources efficiency, but need specific actions. It’s not of secondary importance, as with this formulation, a lot of prevention programs are diluted in recycling and other resources efficiency policies. The requirement of specific prevention plan and their evaluation in the Waste Framework Directive should stay a clear signal that prevention policies deserve dedicated attention and tools. Design for longevity, upgradeability is not the same as design for recycling.

Waste prevention should not be subordinated to LCA studies, as LCA do not integrate prevention criteria and specific dimensions (to be simple, by nature LCA assess what exists, not what has been prevented, or could be prevented). LCA studies and prevention programs are complementary approaches and not subordinated.

The limits between waste and reuse are clear: direct reuse is not waste (see next session). As regard reuse in developing countries, life expectancy should be addressed by design for upgradeability, and qualitative prevention by limiting hazardous contents in products.

The trade-off between quantitative and qualitative waste prevention is a wrong formulation, as both need to be addressed simultaneously. Only on a case by case study could such question being raised and such a trade off be investigated. When such a situation happens, we could refer to “environmentally weighted” indicators with couple quantity and quality.

ETC/SCP

Generally, we suggest adding the aspect provision of a service function instead of focusing only products. I.e. substituting products with services often leads to reduced environmental impacts throughout the life-cycle of the service (also provided by products).

EUROSTAT

I agree with your positions 1 and 2 to broaden the concept - waste prevention has to be seen in a much broader concept of material and energy flows (industrial metabolism).

Municipal Waste Europe

Waste prevention is the first but not the only step in the waste hierarchy. Prevention is not a goal in it self but rather an instrumental way of managing resources in a more sustainable way. The flexibility included in art. 4 item 2 for the waste hierarchy also states that this flexibility "requiring waste streams departing from the hierarchy". Prevention is a part of the whole. The interaction with reuse, recycling and use of recycled materials and substances is essential. Prevention cannot be seen as an independent of environmental thinking.

Discussions will not be entirely avoided with the proposed approach, but the difficult and impossible prioritising between different actions can only be reduced while concentrating on the common goal.

The clarification should include a differentiation of the term "re-use" under the Waste Framework Directive article 3, point 13, which does not affect waste, and re-use as a part of preparing for re-use, the second tenant to the waste treatment hierarchy in article 4, point 2. Re-use in the first case is not waste, while preparations for re-use of waste only affect those substances or objects which the holder discards or intends or is required to discard. It is very important to clarify the difference between these two definitions. We enclose a diagram to illustrate the difference clearly.

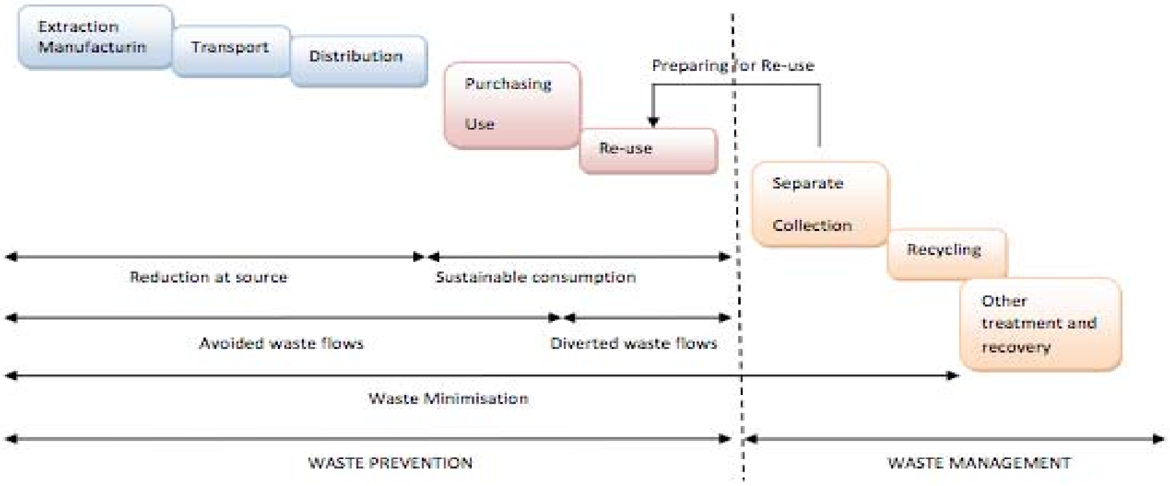

Figure 79: Distinction between reuse and preparing for reuse as defined by Municipal Waste Europe

OECD WGWPR

I do not think that you can separate waste prevention from reducing environmental and health impacts, as well as saving resources, since waste prevention includes both the qualitative (reduction of hazard or risk) and quantitative (reduction of amount) aspect. From the OECD point of view, waste prevention is an integral part of the "reduction" process. Reuse is also an integral part of the prevention, since it saves the resources.

This approach will not solve the second hand product issue, since buying "old" or "used" is an economic rather than environmental issue. However, pursuing remanufacturing and requiring warranties for second-hand stuff may help to solve that issue.

RReuse

This position does not make sense. Waste prevention is one means to minimize negative environmental and health impacts and to save resources, and the WFD hierarchy states that it is the preferable one unless other options are proven to give better results. Of course, it is necessary to look at the consequences for energy demand and resource distribution of reuse or other prevention activities, and, in some special cases, it might be better to avoid certain incompliant reuse schemes. Nevertheless, as a general rule, it is sound to assume that the prolongation of the lifetime of products contributes to resource savings and does not hurt health or environment more than the use of a new product.

Remarks on the bullet points:

First bullet point: This is only one part of the question, the other part is: “is a second hand (reuse) application in a non-OECD country of old cars or EEE with limited life expectancy better than selling new products of low quality, with even worse life expectancy than good quality and tested reuse-products from the EU, with limited but longer life expectancy?”

Selling cheap and low quality new products (cars, computers, mobile phones) to developing countries (which has become normal practice) while, at the same time, recycling potentially reusable products in Europe contributes more to the wasting of resources and energy and produces more environmental problems, waste and health impacts than bringing reusable (tested and functioning) products from Europe to Africa or Asia. There are many examples, especially for computers and mobile phones, where immense social benefit was reached by making available cheap, but quality used appliances to people and institutions (e.g. schools), who could not afford new appliances.

Second bullet point: please refer to the definitions of qualitative and quantitative prevention and the impossible balancing of one against the other (position 3).

Vereniging afvalbedrijven

OK

Position 2

Quantitative environmental and resource depletion prevention (including quantitative waste prevention) should be on top of a hierarchy of life cycle alternatives.

When offering services to society following preferences could be followed in a life cycle perspective:

1. Dematerialised services, without material loops
2. Services in closed material loops, where the material output forms the renewable input. Cradle to cradle approach.
3. Services with input from renewable resources – a cyclic reuse phase – a waste disposal output
4. Services with input from non renewable resources – a cyclic reuse phase – a waste disposal output
5. Services with input from non reusable resources – a waste disposal output

Resources include material, energy, land-use, biodiversity…

Quantitative waste and material prevention would be part of level 1. Qualitative waste and material prevention would be part of steps 2 to 4, together with recycling.

Feedback

CEPI

Position 2 can be agreed to, but the clarification misses the differentiation between depletion by using non-renewable resources and depletion by non-sustainable management of renewable resources. Priority should be given in all steps to use of sustainably managed renewable resources. Therefore Step 2 should in fact be split into two (like steps 3 and 4) where the first would be Closed material loops with input from sustainably managed renewable resources (C2C), and second step Closed material loops with input form non-renewable resources (C2C). N.B.: The output cannot “form the renewable input” if the first input was not renewable.

The use of word “services” should better read “services, products, substances and materials”.

The closed loop production (C2C) would further merit a parameter of proximity, to avoid global haul of materials and products where it can be produced in local loops.

Finally, it is not justified to promote “dematerialised services” unless it means literally non-existing services. A full life cycle perspective is not likely to show that e.g. electronic media is not having an environmental impact equal or greater to traditional, as an example, the life cycle data released by Amazon for the Kindle electronic reader is comparable to 22.5 individually bought paper books per year throughout the life span of the Kindle device. In other words, use of the “immaterial” Kindle is a waste prevention measure only when reading 23 or more individually bought books per year.

The appropriate discussion would be along the decoupling of environmental impacts, not blindly prioritising one technology (see also comments under position1).

EEB

“Waste Prevention” should be on top of preferred services, for example through dematerialization. Qualitative prevention should not be said merely a part of steps 2 to 5, together with recycling. Reducing hazardous contents and harmful environmental impacts from raw materials to waste deserves a specific mention. Cradle to cradle seems difficult if any hazardous substances, this could mean qualitative prevention appears a condition to recycling for steps 2 to 5.

Qualitative prevention should be assessed together with quantitative prevention (e.g. environmentally weighted material consumption) when needed.

ETC/SCP

We agree, especially in light of the previous comment on services.

EUROSTAT

The sequence of preferences under position 2 seems a good start from a material flow perspective. In the long term and in view of a cycling economy, we may even get rid of the narrow "waste concept" and will only talk about material flows.

Municipal Waste Europe

Municipal Waste Europe finds that in the perspective of environmental protection including human health, qualitative prevention is of more importance. Reduction of hazardous substances and materials is in that aspect, of first importance to prevent, especially where alternative substances provide equal functions. In the aspect of saving resources, qualitative prevention can be of more importance. The two are however not exclusive but rather supportive of each other.

The presence of hazardous substances in waste provides extra difficulties for waste treatment. Its avoidance is the single greatest improvement and support for the development of sustainable waste management that can be achieved. This requires qualitative actions.

The discussion paper introduces clarifying preferences regarding services, not products.

It would be interesting to analyse the waste prevention effects on the service sector.

OECD WGWPR

I would say that qualitative prevention would be the priority and would be easier to achieve than the quantitative prevention. Let’s keep in mind that as long as GDP growth is the main target of current economic system, the consumption waste generation will increase due to the fact that most of the GDP growth is material-related.

RReuse

It is simply not true that quantitative waste prevention “would be part of level 1”. On the contrary, waste prevention is most important for levels 3 to 5, striving to minimize the waste disposal output that is not avoidable (and being 100% successful in level 2).

Qualitative waste prevention is not dealt with in this hierarchy at all and can be applied to all levels.

According to the Austrian legal definitions, for example:

“Qualitative prevention” is defined as replacement of a substance or component of a product by a less toxic or less problematic substance or component, thus not changing the functional attributes or the mass of the product, but instead improving the quality of waste (less toxic, better recyclable).

“Quantitative prevention” is defined as measures taken BEFORE a product becomes waste,

Re-use of products is also seen as a prevention measure in Austria, BEFORE a product becomes waste, thus the fostering of repair services and repair networks is seen as a waste prevention measure in Austria, as well as refillable bottle systems.

Thus there should be no trade off between qualitative and quantitative prevention at all because both measures have to be taken if possible. There should be no legal basis to say that if we have less toxic cars, we do not have to reduce the amount of cars wasted every year.

Vereniging afvalbedrijven

Position 2 is too dogmatic: does this lead to a tunnel vision or good policy measures (maybe qualitative approach is much more realistic and beneficial than quantitative approach or they can reinforce one other)? Why should you want to make this strict distinction?

Position 3

Quantitative prevention *is an absolute concept. Qualitative prevention is a gradual concept. Therefore quantitative prevention usually is better than qualitative prevention.*

The concepts of quantitative and qualitative prevention can theoretically be balanced. When waste or waste treatment does not have any noxious impacts, why should its generation be prevented? Vice versa, when the generation of the waste is obviated, it cannot cause any environmental impact. It could be kept in consideration that this balance is in a way asymmetric. Quantitative waste prevention is absolute. If a waste does not exist, it cannot cause any harm whatsoever. Qualitative waste prevention is more relative. If possible harm from a certain constituent is avoided, other harm could occur from other constituents or from the substituent. Qualitative prevention focuses at certain, well defined aims, like prevention of eco-toxicity or health risks, but could be neutral or negative to other types of impacts, like energy use in the treatment installations, resource use, impact on land use, supplementary shipments, or even have positive aspects like employment generation in the waste treatment industry. The overall effect of waste generation/treatment plus qualitative prevention should be balanced against quantitative prevention or non-generation of waste.

Feedback

CEPI

Position 3 cannot be agreed with. Quantitative prevention is an absolute concept only on the surface, but does not deliver the goals described in Position 1 and 2 if it is not combined with qualitative. For example, prevention of 1 tonne of used paper is not as important as prevention of 1 tonne of used plastics or electronics which may not be as important as prevention of 1 tonne of hazardous chemicals.

The experience is that most quantitative prevention targets are set arbitrarily and are not based on life cycle thinking. This, in addition, is related to the blindness to other harm occurring from the substituting product, material or technology that is used instead of the prevented one.

Finally, the problem of quantifying "what does not exist" persists in prevention and is not likely to be overcome: how can one measure what was prevented, and how can one attribute it, in the complexity of society, culture and economy, to the prevention measures?

EEB

This position looks like a pure logical formulation, which may not be of any relevance in concrete situation and decision making.

As a rule of thumb, the avoidance of waste is the best, EVEN if waste treatment is of no harm. When waste is to be generated, non hazardous waste should be preferred, if other impacts are similar. When a balance between hazardous waste avoidance and other environmental impacts needs to be considered, approved LCA and environmental weighting of resources should be used.

But, LCA analysis should be used where and when they add value, not as a pretext to delay or dilute prevention actions, both quantitative and qualitative.

ETC/SCP

We suggest emphasizing that this approach refers to the whole life cycle of the products/services, and trade-offs between certain environmental impacts throughout the life-cycle should be considered.

EUROSTAT

It remains unclear to me what "qualitative prevention" should be (positions 3, 4 and 5)?

Municipal Waste Europe

It is clear that quantitative prevention is easier to measure than qualitative prevention. An absolute concept does however not mean it is better. Actions for preventing waste are connected to the protection of the environment and human health. Prevention can however not be a target in it self, not even if the measuring becomes difficult. Investments of time and resources into prevention measures need to be balanced to the results. The best prevention therefore concentrates on the most hazardous substances or waste streams.

The ARCADIS document clarification to position 3 uses an uncommon terminology when referring to the hazardousness of substances and waste streams and the potential alternative risks with the substitution principle. It is not in line with the terminology of the Commission Guidelines for waste prevention and it makes the text very difficult to understand.

OECD WGWPR

I do not agree. Mandatory environmental product requirements can easily restrict the amount of harmful or hazardous substances (hazardousness) in materials and products (c.f. RoHS).

RReuse

How does this piece of formal logic relate to real world problems?

Of course it is better to avoid waste altogether than to make it less dangerous for health or environment, but for waste that is not avoidable (and for the foreseeable future, such waste will exist), it is better to bring it into a quality that is the least dangerous one possible.

On the other hand, it is complete nonsense to state that when waste or waste treatment does not have any noxious impact, its generation should not be prevented. By definition, waste is a formerly useful material that can no longer be used, and as such, it is a lost resource. The energy to make this material available and to bring it into a useful form is also lost. That is more than enough reason to prevent it.

To produce fewer products is quantitative prevention, and to produce the remaining products with less noxious impact is qualitative prevention. BOTH are needed, and none of the two can replace the other. Only if you do not produce any more cars at all, you do not have to consider producing cars with less toxic components. Since this is not realistic, both concepts have to be applied on every product!

Therefore, from our point of view, there is no balancing of quantitative and qualitative waste prevention whatsoever.

Vereniging afvalbedrijven

Quantitative prevention is not necessarily better: waste is a by law defined substance (all material which is discarded). It does not say anything about the value in it for the broader economy. It could be that waste substance is much better used again then the original product. Think about glass waste which is recycled for making new glass. To say that quantitative prevention is better than qualitative prevention is meaningless and could lead to wrong political conclusions.

Additional remarks:

What is the definition of quantitative and qualitative prevention? What is the legal basis for this definition?

To our opinion 'qualitative waste prevention' is to be discussed. If possible harm of a constituent is avoided, this is to our opinion 'harm prevention' not 'waste prevention'. In the text above also 'eco-toxicity prevention' and 'health risk prevention' are mentioned. Again, to our opinion, something different than 'waste prevention'.

General:

Are definitions / will definitions be attuned at EU level? This is crucial for uniform implementation across EU

Position 4

Qualitative prevention is not a good concept to order in the waste treatment hierarchy.

Article 4 of the waste Framework Directive includes the waste treatment hierarchy. Its categories are:

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

Step one includes "prevention", but does not make a distinction between qualitative and quantitative prevention. Qualitative prevention however never stands on its own. Since the generation of the waste is not prevented, it will need to go to steps (b), (c), (d) or (e). Qualitative prevention can focus on a further step, trying to avoid environmental impact when a waste is recycled, incinerated or making it ready to fulfil the acceptance criteria to be landfilled. The waste treatment hierarchy should be read with care in this approach. It is better that a waste as such is recycled (c), instead of being adapted through qualitative prevention (a) and further on landfilled or incinerated. Although qualitative prevention occurs in those specific cases, the waste treatment solution remains less preferable than recycling.

Step one could be limited to quantitative prevention, while qualitative prevention could be upgraded to a general a priori condition that is applicable (and should be applied) on all other steps in the waste treatment hierarchy.

Feedback

CEPI

Position 4 cannot be agreed with as it implies a "mechanical reading" of waste hierarchy which is strange to reality, and conflicts with Article 4(3) of the Waste Directive. Instead of reading it as a priority order of (multiple) actions, the author of Position 4 seems to see it as mutually exclusive list of actions with no interactions between them: for example "preparing for re-use" is likely to result in waste waters and other materials being disposed of. Again, the definition of "prevention" in Article 3(13) of Waste Directive would help reading the Waste Hierarchy in a right (and practicable) way.

The last paragraph under the clarification seems to conflict with the definition of waste prevention in the Waste Directive and should be rejected.

Applying waste prevention should be done concentrating on the key environmental impacts and taking into account the whole life-cycle of products and materials. Such measures should pursue the objective of breaking the link between economic growth and the environmental impacts associated with the generation of waste, which is also the guidance given in the Waste Directive.

EEB

Once again, this position tends to extrapolate from the necessity of a case by case consideration to a general formulation, and may then loose any relevance. The 5 steps WFD hierarchy just avoids this, by setting prevention at the top, and by defining prevention both a quantitative and qualitative manner. The sentences "The waste treatment hierarchy should be read with care in this approach. It is better that a waste as such is recycled (c), instead of being adapted through qualitative prevention (a) and further on landfilled or incinerated" do not make sense: it is obvious in the hierarchy that recycling should be preferred to landfill or incineration. In addition, recycling is often easier when no harmful substances are integrated in the initial product.

An issue could be the availability of recycling processes able to recycle waste, even containing hazardous substances, with regards to the temporary unavailability of such recycling process for a "substitute" waste with no hazardous substances, then forcing to incineration or landfill. This could be a pure theoretical formulation, or just testimony of a situation of an emerging technology, having not yet the associated recycling process. In this potential situation, level playing field for the less hazardous waste should be the priority.

ETC/SCP

In general we agree with this point. However, please be aware of Article 4, 2 saying that "when applying the waste hierarchy…. Member States shall take measures… that deliver the best overall environmental outcome". In order to do this, a life cycle thinking/LCA must be applied not only between point a) to point e), but also within a) or within c). In that way you can argue that a qualitative prevention can/will be ranked higher than quantitative prevention. However, the problem is that the WFD does not set any common standards for how to make the life cycle thinking or the LCA or how to make the weighting of the different parameters in the LCA.

Municipal Waste Europe

Municipal Waste Europe finds the clarification filled with misconceptions. Qualitative prevention is best judged through a life cycle approach, the same judgement to be used for the evaluation of the entire waste hierarchy in the Waste Framework Directive. Development of Life Cycle Assessment methods is one tool to use in these assessments.

With a clear understanding of qualitative prevention definition, there seems to be no reason why it cannot stand alone. The relationship to the other steps in the waste hierarchy seems to be confused. The proper treatment of waste, as to its suitability for recycling, recovery or disposal is decided through the life cycle approach, as the waste hierarchy is not absolute.

OECD WGWPR

See my response to Position 3.

RReuse

Why make things so complicated? The waste hierarchy established in the Waste Framework Directive is clear enough, and, since prevention is the top priority, it should be clear that both forms, quantitative and qualitative, should be applied.

Qualitative prevention has to be done before products become waste, by design measures or activities in the use phase influencing the material content of the waste to be generated. The outcome of qualitative prevention is the prevention of certain types of wastes (usually classified as "hazardous"), while still creating other wastes, hopefully less problematic. These wastes might be easier to recycle, or might still need to go to incineration or landfill, but hazards have been avoided.

The alternatives “qualitative prevention -> landfill/incineration” on the one hand and “no prevention -> recycling” on the other are artificial constructs, which should not be discussed on such a general level, but only in relation to concrete problems at hand. That kind of reasoning is not applicable to the problems encountered in reality.

Because qualitative prevention strives to minimize risks from wastes and make wastes less hazardous, it is generally a better option than to rely on one of the other options for the original (not qualitatively prevented) waste, and that is why it is rightly at the top level of the hierarchy.

Vereniging afvalbedrijven

It is questionable if the approach proposed is in line with the WFD (check). The WFD is in the first place a framework for Member States and it is clear that as well qualitative as quantitative prevention are elements of prevention as such.

Additional remark:

By differentiating between quantitative and qualitative prevention things become very complicated. To our opinion ‘waste prevention’ means there is no physical waste. Therefore prevention is solely quantitative.

Position 5

Reuse is prevention, preparing for reuse is no prevention but there is a thin line between both concepts

Different approaches exist within the definitions or concepts on reuse in Member State waste prevention plans and at OECD or Basel level. Reuse (according to David Parker and Phil Butler, Envirowise 2007) can be subdivided in following categories:

- Straight reuse, possibly by someone else, possibly in a different way.
- Refurbishment – cleaning, lubricating or other improvement.
- Repair – rectifying a fault.
- Redeployment & cannibalisation – using working parts elsewhere.
- Remanufacturing; the only option that requires a full treatment process – like new manufacture – to guarantee the performance of the finished object.

Except for the first category, all these activities preparing for quantitative prevention belong to step (b) of the hierarchy.

Two discussion points can be identified:

- When does refurbishment (e.g. cleaning bottles for reuse) starts to be preparing for reuse, and would thus be classified as a waste treatment activity? Should repair, redeployment, remanufacturing be considered as reuse because they inevitably lead to reuse of the product as such?
- Does reuse (as stated in the Austrian waste management act) include 'continuing to use': the non intended, yet permissible use on an object). Even for another purpose?

Feedback

CEPI

Position 5 the clarification cannot be agreed with, as it is not in line with the Waste Directive. Were the discussion above approved, one should also accept the "thin line" between prevention and recycling, as well as prevention and other recovery, probably also between disposal (of non-hazardous materials). Again, the Waste Directive definition on "preparing for reuse" is clearly related on "products or components of products that have become waste are prepared so that they can be re-used without any other pre-processing"

From this and from the waste hierarchy, it should be clear that all steps (a) to (e) apply to waste and e.g. cleaning bottles for reuse is a waste treatment activity.

What needs to be clarified is the concepts of prolonging life span of a product/material (e.g. second hand cars or clothes, car-pools or libraries) and defining when the multiple uses/owners/users are "normal life span" of a product/material, and when it qualifies for reuse. Secondly, it would be necessary to develop clear and verifiable methods of quantifying reuse. Thirdly, the quoted list by Parker & Butler does not make it clear when a process is reuse instead of recycling.

EEB

Straight reuse is clearly reuse.

One way to answer the question is to consider if there is a "returnable" scheme: if any, then cleaning, repairing… could be considered as reuse (prevention). Or otherwise:

If the processes listed in the clarification are done within a value chain that doesn't have to do with waste (e.g. selling furniture to a second hand market that redeploys those) we talk about reuse, if done so by a recycling company we talk of preparation for reuse.

If a product is used even for a non intended initial purpose, it could be considered reuse, providing THERE IS NO OTHER ENVIRONMENTAL CONSEQUENCES generated by this not initially intended use.

ETC/SCP

We support to classify repair, redeployment, etc. as reuse in case it is aimed at using the product further in its original function.

We agree that continuing to use by someone else should be considered as reuse. Use for other purpose can be considered reuse if it substitutes any new product.

Municipal Waste Europe

Municipal Waste Europe finds that the ARCADIS clarification need a reference to the Waste Framework directive in order to clarify the terms reuse and preparing for reuse. Applications in Member States and by academia are interesting but not when contradictory to current legal definitions.

See position 1 for further discussion about the terms.

Cleaning of bottles for re-use is traditionally not included in waste treatment processes, as the bottles are not waste (see the re-use definition in Waste Framework directive article 3 point 13.

OECD WGWPR

The whole “preparing for reuse” is only related to the too broad waste definition of the EU. The best way to get rid of this is to define the term “discard” in such a way that not everything is waste.

Reuse as a term is only related to something which is already used, i.e. products, materials, reuse can never be related to waste, since nobody has before used the waste. For this reason, the whole EU logic that a product becomes waste before it is reused is not supported by many other countries. For instance, based on this logic, the refillable empty bottles are waste before refilled!!??

RReuse

The “thin line” referred to in this position is the difference between waste and product, and that is a completely legal problem.

The activities listed (direct reuse, refurbishment, repair, remanufacturing) differ in the quality of the outcome (“as is”, “functioning”, “equivalent to new”), but apply to reuse as prevention and to preparing for reuse all the same. When a product has become waste (because the last owner discarded it), it has to be “prepared for reuse”, even if it is as good as new or in a state ready for direct use. When a product is handed in for reuse (e.g. as a donation), it will be reused, even if it needs cleaning and repair or upgrading before anybody want to use it again.

There will be no discussion points on what is allowed as reuse. As long as a product is still a product (which has been prevented to become waste), I am allowed to put it to any use that it is fit for and that is not in conflict with other law (even growing flowers in a washing machine, if I like to). “Preparing for reuse” must lead to a product which is fit for the purpose for which it was conceived, but still it is up to the new user what he/she wants to do with it.

To conclude, the whole sentence “Except for the first category, all these activities preparing for quantitative prevention belong to step (b) of the hierarchy” is a wrong assumption resulting from a wrong interpretation of the second step of the waste hierarchy. To be clear on the first two steps of that hierarchy and where reuse activities fit, step one include reuse of products (whether that is straight reuse, cleaning, refurbishment, repair) whereas step two relates to reuse of waste (with the exact same activities).

(RREUSE adds a comment regarding a factual error in the description of the Austrian waste management act, as cited above. This has been corrected in paragraph 3.1.3.9.1)

Vereniging afvalbedrijven

What is reuse exactly?

Additional remark:

How can (all categories of) reuse be the same as (waste) prevention? In the hierarchy of life alternatives, wouldn’t this be only possible in the hypothetical situation of reuse of materials without any loss of quantity and quality?

=> Reuse is something else than (waste) prevention. You cannot reuse when waste generation has been prevented.

Visual map and factsheets

The different ways in which waste can be prevented are mapped out, reflecting the different kinds of activities and processes contributing to waste prevention. Waste prevention policy actions can be visualised on the axes “phase in the life cycle” and “kind of instrument”.

- The life cycle contains the steps: design, extraction, production, distribution, consumption/use, waste, and end-of-waste.
- The instruments are defined as: legal instruments, economic instruments, communication and other instruments, technical instruments.

Each bullet in the scheme represents a prevention action. For each different prevention action a factsheet is developed to support the visual map. Moreover for each phase in the life cycle an umbrella factsheet is developed.

Following factsheets have been developed:

- Instrumental factsheets: 1 awareness and education, 2 ecodesign, 3 extended producer responsibility, 4 green public procurement, 5 labelling / certification, 6 marketing, 7 positive and negative financial stimuli, 8 prevention targets, 9 product standards, 10 reuse, 11 technology standards, 12 voluntary agreements.
- Lifecycle factsheets: 13 design, 14 extraction, 15 production, 16 distribution, 17 use, 18 waste, 19 end-of-waste.

Feedback

The feedback is more of a factual nature and has been integrated in the different factsheets in the core report.

CEPI

The visual map:

The Legal instruments seem to omit the wide range of legislation in product specific measures (WEEE, ELV, etc) and the eco-design directives (EuP, ErP and ExP). These would apply to, at least, Design, Distribution and End-of-waste where the first mentioned is self-explanatory, the second includes i.a. access to market (positive or negative lists), and the last e.g. recyclability.

The Technical instruments seem to omit recycling from production (which probably is better name for “reuse through remanufacturing”) and Recycling in End-of-waste (as probably the most important way of reducing environmental impact of waste – c.f. Waste Directive Article 3(12)b). Furthermore, a very important Technical instrument related to Waste, Separate collection, is missing and should be added. Separate collection is also an important legal instrument that could be added to first row of the column under Waste.

(ARCADIS: not included, no prevention instruments)

The idea of labelling voluntary agreements and GPP as “communication/other” hardly makes them right where GPP is well based in legislation, and voluntary agreements are not just “communication”. Maybe the solution would be to create new row of “voluntary instruments” or simply split them between the existing ones excluding communication.

The factsheets:

The idea of fact sheets is encouraged, but developing one may be more difficult than it first appears. Firstly, reading through the fact sheets it becomes clear that most areas of waste prevention are already well regulated through IPPC, Eu/r/xP and other product specific Directives, and the need for further measures in waste prevention can therefore be questioned.

Secondly, the discussion between extractive processes and bio-based, non-extractive renewable production is not well developed and is in particular confusing in the one on “Extraction”. If the author seems important to discuss Forestry (which is not an extraction process), similar observations should be made about fossil fuels and metals: depletion of resources, land use and unfortunately very often human rights are an issue there, whereas forestry – being based mainly in European (sustainably managed as demonstrated by e.g. FSC, PEFC) forests – do not commonly have those problems. Even more strangely, the Examples do not list fossil materials and products (such as chemicals and plastics): here the bio-diversity impact, soil and water pollution, climate change impact, non-sustainable use of land, human rights issues etc. should be raised too, in addition to the points made under Fossil fuels.

In case a fact sheet on sourcing of raw materials is made, in addition to Extraction, other issues such as food crops and meat and dairy production probably need to be discussed in balance with the ones raised now in Extraction.

The foot note 1 should include “maintenance” between “construction” and “decommissioning” of the installations.

Under Design, the reference to the Essential Requirements, notably to light weighting, would be appropriate as this has already lead to significant results despite the technical challenges it raises to meet other technical specifications simultaneously. In the case of paper, a similar trend to light weighting is also clearly visible in printing and graphic papers, without the legal obligation to do so.

Under Distribution, the sole emphasis on reusable packaging may be biased. The attached study by ITENE shows that in the case of fruit and vegetable, a transport distance superior to 100km makes the use of recyclable packaging more environmentally beneficial than reusable packaging.

Under Waste, the note about “design for recycling“ not being prevention clearly conflicts with Waste Directive Art 3(12)b, and even more clearly conflicts with Packaging and Packaging Waste Directive definition of prevention under Article 3(4) which explicitly and in particular mentions “developing clean products and technology”. An example on design for better recyclability – and avoiding waste from recycling operations – is attached in the document from Spain (RAL).

Furthermore, the source separated collection schemes should not be limited to “preparation for reuse” but is equally important for recycling, as other forms of collection result in more contamination and secondary waste from recovery operations. Equally, the “source separated collection or central sorting for recycling” cannot be qualified as “non-prevention”, as explained before: source separation clearly prevents the amount of waste (in the new cycle of production).

Finally, the End-of-waste rightly gives the example of “minimisation of raw materials used: reducing material inputs by using secondary raw materials” which should be reflected in the other fact sheets (which now are conflicting with this example).

EEB

A good initiative to have this visual map and the different instruments associated to each LC steps. But:

- The instruments are too generic and deserve more precise description as, for example, awareness and education are not the same at each step, not targeting the same public, not mobilizing the same pedagogy and educational tools (from operator training and integration into professional competency, to informing consumer, there is a huge gap…).
- Shall we consider “choice editing” and other distribution strategy as an instrument to add in the distribution stage?

At least, some good example and case study could be associated to each instrument in the complementary factsheets.

ETC/SCP

Visual map:

Suggest including instruments supporting the use of renewable resources under Extraction stage.

Lifecycle factsheets:

Design:

- Add functions/services not only products.
- Add total material requirement of products/ecological rucksack.

Extraction:

- Distinguish between renewable (sustainable biomass utilization) and non-renewable resources.

Production:

- Add environmental management systems (ISO14001 and EMAS). EMAS call for defining measurable objectives in the continuous improvement of the environmental performance of the production site.
- Suggest highlighting calculation of total cost of waste generation: costs associated with purchasing, transport and processing of material that will become waste.
- We think BAT is not specific enough on waste prevention for most sectors**.**

Distribution:

- Suggest to emphasize minimization of packaging waste includes the total amount of primary, secondary and tertiary packaging.

Use/consumption:

- For the list of examples, we suggest to add buying services instead of products. Buying experience (concert, theatre) instead of products as presents.

Waste

- We will suggest that you under technical instruments mention reuse of certain parts of discarded products.

End-of-waste

- It is not so clear for us how you find that End-of Waste criteria can contribute to waste prevention, since the amounts we talk about have already been waste at some stage. In our opinion it is very important that the criteria set for end-of waste are so strict that the standards secure a high quality of the end of waste material and high quality recycling. If, the standards are of a too low quality, you will get “down recycling” and not any qualitative improvement.

EUROPEN

Overall Observations

Mindful of the foregoing remarks, we respectfully suggest that references to packaging in the draft document are too numerous and should be subjected to a fundamental review because in the present document the function of packaging does not appear to be properly understood. This is illustrated in the life cycle fact sheet on Distribution which seems to suggest that the greatest opportunities for prevention at the distribution phase lie in “a reduction of the amount of primary packaging waste”. We are at a complete loss to understand the logic behind this statement since packaging waste is not generated during distribution and without packaging there can be no distribution of products. A fundamental function of packaging in the distribution phase is the prevention of waste. We therefore urge a rethink of the statement in the factsheet under the Strategy caption and in the section headed “impact on other phases in the life cycle of materials and products”.

Municipal Waste Europe

The fact sheets need to be revised and carefully adjusted. The sheets should to contain comparable texts on identical or similar subjects. They also include measures not strictly seen as prevention of non-waste, which is good and showing the complex supporting measures that will reduce environmental impact from waste. It clarifies the connection between environmental targets and the quantitative measures as the waste phase prevention actions often are identical to the non-waste prevention actions, for example to prepare for reuse through reparability.

OECD WGWPR

From my point of view, prevention targets do not fit for consumption. How would you apply those?

Also the end-of-life is unclear in this context; if it means remanufacturing, recycling, refurbishment, etc., it is clear, but if it means "preparing for re-use", then it is not clear.

Overall, it is not clear how the Member States are supposed to make progress in waste prevention under the current economic system which is totally consumption driven?

RReuse

Visual map

Public procurement is in the wrong place on the map: this is a legal instrument. If public procurement regulations would force public institutions to prefer used products, rent products instead of buying them and prefer high quality repairable products, or simply consider the option of repair before buying something new, much could be gained.

Life cycle fact sheets

- On the "Use/Consumption" lifecycle factsheet: An important aspect of sustainable consumption is making optimal use of a product, i.e. using it as long as possible, considering repair and/or upgrade if necessary. In our opinion, this should definitely be mentioned in the examples.
- On the "Waste" lifecycle factsheet: Qualitative prevention and design aspects do not belong to the waste phase, because here one has to deal with the waste as it is created by those who discard it. Any attempt to influence the waste content in this phase is to qualify as treatment.
- "Adapted collection" is not only important for reuse, but also for recycling, because the quality of the collection can have decisive influence on the quality of the recycled products. Examples include biowaste, which needs to be clean for quality composting, or WEEE, which needs to be undamaged to be properly dismantled.
- On the "End-Of-Waste" lifecycle factsheet: The factsheet does not seem to fit in the proposed framework. "End-Of-Waste" is not a lifecycle phase, but a transition from waste to product, which is legally placed at a certain point in the waste treatment phase. For that reason, the examples are misleading and should be moved to the corresponding life-cycle phase: "Minimisation of raw material use" belongs to the production phase, "Quality control" to the waste phase, and so on.

Vereniging afvalbedrijven

Visual map

- Isn't extended producer responsibility (more) a legal instrument than an economic instrument?
- 'Technical instruments': 'Best practices' / 'Technical standards'?

- End of Waste, Legal instruments: EOW framework (i.e. WFD criteria on EOW), REACH
- End of Waste, Technical instruments: EOW criteria (i.e. EOW standards for metal)

Life cycle factsheets

Design

- Minimising is preferred over reducing (for instance when speaking about environmental impact or amount of packaging)
- Although this document is on waste prevention, it might be considered to include a note on other issues (like social issues). Production, for instance, can be environmental friendly and cause a minimum of waste due to socially irresponsible labour practices.
- Comment on the design phase being more than product oriented ecodesign: Also here a pitfall can be that the design causes no waste at production / assembling site, but might cause a lot of waste elsewhere; is that in the scope of this document?
- General note: It might be considered to include the supply chain in the design phase. Waste prevention can lead to increased pollution (i.e. due to long travel distances of components).

Production

- Minimizing product failure has been suggested as an example
- EPR is seen as a legal instrument rather than an economic instrument (see above)

Use / consumption phase

- Comment on ‘smart shopping’: The example of ‘plastic bottles’ is to be debated. It’s a possible example where waste reduction might lead to more pollution due to the alternative packaging

Waste phase

- It is argued that the design examples in this area should be moved to the fact sheet design

End-of-waste phase

- REACH has been added as an example

Annex 2: Main data on waste generation and treatment flows

Table 68: Estimated Total Waste Generation in the year 2006 in EU 27 in million tonnes (Mt) by EWC-Stat Category (derived from EUROSTAT 2009a)

EWCStat-Name	EWCStat-#	EU27	BE	BG	CZ	DK	DE	EE	IE	GR	ES	FR	IT	CY	LV
Spent solvents	EWC_011	2.9	0.21	0.00	0.01	0.01	0.71	0.00	0.14	0.00	0.22	0.41	0.28	0.00	0.00
Acid, alkaline or saline wastes	EWC_012	8.1	0.19	0.44	0.15	0.01	1.51	0.03	0.02	0.02	0.77	0.33	0.72	0.01	0.01
Used oils	EWC_013	6.5	0.18	0.00	0.06	0.08	0.98	0.06	0.01	0.09	0.36	0.50	0.64	0.02	0.02
Spent chemical catalysts	EWC_014	0.2	0.01	0.00	0.00	0.00	0.03	0.00	0.00	0.00	0.03	0.01	0.04	0.00	0.00
Chemical preparation wastes	EWC_02	7.2	0.19	0.01	0.09	0.03	1.34	0.08	0.15	0.00	0.75	0.59	0.61	0.00	0.01
Chemical deposits and residues	EWC_031	20.7	0.76	0.15	0.25	0.00	3.11	1.05	0.06	0.05	0.76	0.93	1.92	0.00	0.01
Industrial effluent sludges	EWC_032	11.0	0.45	0.10	0.31	0.00	1.85	0.29	0.01	0.12	0.41	0.69	2.70	0.07	0.02
Health care and biological wastes	EWC_05	2.4	0.12	0.00	0.02	0.01	0.20	0.00	0.00	0.07	0.65	0.13	0.14	0.00	0.00
Metallic wastes	EWC_06	102.5	5.60	0.37	5.43	0.64	7.69	0.77	2.04	1.06	3.27	13.50	7.64	0.04	0.08
Glass wastes	EWC_071	15.4	0.75	0.03	0.22	0.13	2.16	0.06	0.17	0.27	1.48	2.21	1.42	0.02	0.04
Paper and cardboard wastes	EWC_072	64.2	4.52	0.32	0.65	0.79	9.33	0.44	1.12	0.47	4.65	8.09	5.61	0.11	0.03
Rubber wastes	EWC_073	3.8	0.15	0.03	0.02	0.05	0.40	0.05	0.01	0.05	0.43	0.32	0.19	0.01	0.00
Plastic wastes	EWC_074	15.6	0.63	0.03	0.21	0.05	1.41	0.09	0.36	0.76	1.62	2.07	1.56	0.09	0.01
Wood wastes	EWC_075	86.2	1.80	0.16	0.76	0.86	8.83	1.79	0.43	0.75	1.91	9.89	2.44	0.05	0.26
Textile wastes	EWC_076	3.8	0.63	0.01	0.07	0.00	0.18	0.01	0.18	0.02	0.09	0.44	0.82	0.02	0.00
Waste containing PCB	EWC_077	0.1	0.01	0.00	0.00	0.00	0.02	0.00	0.00	0.00	0.01	0.02	0.06	0.00	0.00
Discarded equipment (excluding discarded vehicles and batteries and accumulators waste)	EWC_080_NOT_081_0841	3.5	0.20	0.01	0.03	0.04	0.77	0.01	0.02	0.01	0.20	0.11	0.41	0.00	0.00
Discarded vehicles	EWC_081	14.2	0.30	0.02	0.01	0.19	0.84	0.02	0.01	0.02	0.98	1.85	5.52	0.00	0.05
Batteries and accumulators wastes	EWC_0841	1.6	0.06	0.00	0.01	0.00	0.30	0.00	0.01	0.04	0.13	0.26	0.20	0.00	0.00
Animal waste of food preparation and products	EWC_0911	13.1	0.47	0.01	0.07	0.00	0.36	0.04	0.24	0.29	2.35	1.25	0.14	0.07	0.05
Animal faeces, urine and manure	EWC_093	125.2	0.03	0.34	0.00	0.00	1.14	0.00	0.01	4.42	14.05	0.15	0.47	0.11	0.02
Animal and vegetal wastes (excluding animal waste of food preparation and products; and animal faeces, urine and manure)	EWC_09_NOT_0911_093	97.0	3.89	0.63	0.64	0.19	10.55	0.26	1.06	0.07	4.26	4.94	8.74	0.16	0.13
Household and similar wastes	EWC_101	204.5	5.02	4.10	3.19	3.14	20.93	0.65	0.37	4.93	23.24	25.00	25.06	0.26	0.96
Mixed and undifferentiated materials	EWC_102	43.8	3.34	0.06	0.17	1.08	4.50	0.03	0.41	0.08	1.13	12.52	3.36	0.10	0.01
Sorting residues	EWC_103	36.6	1.12	0.06	0.24	0.00	11.18	0.01	0.28	0.25	1.00	3.62	7.83	0.00	0.01
Dredging spoils	EWC_113	46.4	0.36	0.71	0.19	0.00	0.30	0.08	0.00	0.00	0.15	0.01	0.22	0.00	0.00
Common sludges (excluding dredging spoils)	EWC_11_NOT_113	17.4	0.43	0.03	0.48	0.19	0.98	0.36	0.10	0.14	1.84	1.49	1.18	0.26	0.02
Mineral wastes (excluding combustion wastes, contaminated soils and polluted dredging spoils)	EWC_121_TO_125_NOT_124	1,833.4	24.47	227.41	11.30	5.76	238.31	7.29	22.43	21.81	84.42	349.86	65.18	0.37	3.43

Combustion wastes	EWC_124	154.4	2.93	7.45	2.04	1.43	27.94	5.41	0.32	15.52	9.32	4.27	8.39	0.00	0.10
Contaminated soils and polluted dredging spoils	EWC_126	9.4	0.53	0.00	0.14	0.00	4.44	0.00	0.00	0.00	0.11	0.33	0.50	0.00	0.00
Solidified, stabilised or vitrified wastes	EWC_13	3.5	0.01	0.00	0.11	0.00	1.45	0.04	0.00	0.02	0.36	0.14	0.66	0.00	0.00
Total Waste		**2,954.2**	**59.4**	**242.5**	**26.9**	**14.7**	**363.8**	**18.9**	**29.9**	**51.3**	**160.9**	**445.9**	**154.7**	**1.8**	**5.3**

EWCStat-Name	EWCStat-#	LT	LU	HU	MT	NL	AT	PL	PT	RO	SI	SK	FI	SE	GB
Spent solvents	EWC_011	0.00	0.00	0.04	0.00	0.21	0.02	0.01	0.06	0.00	0.01	0.01	0.02	0.05	0.42
Acid, alkaline or saline wastes	EWC_012	0.00	0.00	0.02	0.00	0.50	0.13	0.31	0.23	0.49	0.00	0.04	0.97	0.27	0.87
Used oils	EWC_013	0.01	0.01	0.06	0.00	0.09	0.08	0.04	2.30	0.04	0.01	0.03	0.09	0.14	0.58
Spent chemical catalysts	EWC_014	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.03
Chemical preparation wastes	EWC_02	0.01	0.01	0.05	0.00	0.14	0.05	0.25	0.49	0.25	0.03	0.03	0.14	0.10	1.78
Chemical deposits and residues	EWC_031	2.02	0.01	0.14	0.03	0.64	0.64	3.03	2.31	0.18	0.37	0.10	0.32	0.50	1.34
Industrial effluent sludges	EWC_032	0.02	0.00	0.17	0.00	0.25	0.05	1.45	0.47	0.04	0.03	0.25	0.25	0.37	0.65
Health care and biological wastes	EWC_05	0.00	0.00	0.04	0.00	0.01	0.03	0.03	0.24	0.02	0.00	0.05	0.01	0.01	0.56
Metallic wastes	EWC_06	0.66	0.19	1.59	0.02	2.01	1.80	3.94	6.15	2.01	0.70	0.72	1.12	1.88	31.56
Glass wastes	EWC_071	0.12	0.08	0.07	0.00	0.55	0.40	0.50	0.48	0.94	0.06	0.04	0.22	0.34	2.70
Paper and cardboard wastes	EWC_072	0.09	0.10	0.57	0.00	2.75	2.02	0.77	2.38	1.10	0.18	0.20	1.23	2.41	14.24
Rubber wastes	EWC_073	0.09	0.01	0.02	0.00	0.11	0.07	0.14	1.07	0.03	0.01	0.02	0.05	0.05	0.38
Plastic wastes	EWC_074	0.03	0.03	0.15	0.00	0.32	0.38	0.33	1.00	0.58	0.04	0.08	0.13	0.19	3.45
Wood wastes	EWC_075	0.22	0.11	0.48	0.00	1.78	3.13	3.15	1.24	1.47	0.79	0.77	13.34	22.17	7.61
Textile wastes	EWC_076	0.01	0.00	0.05	0.00	0.13	0.03	0.07	0.48	0.25	0.01	0.02	0.01	0.02	0.25
Waste containing PCB	EWC_077	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Discarded equipment (excluding discarded vehicles and batteries and accumulators waste)	EWC_080_NOT_081_0841	0.02	0.01	0.04	0.00	0.20	0.13	0.05	0.22	0.00	0.00	0.02	0.09	0.22	0.65
Discarded vehicles	EWC_081	0.06	0.00	0.04	0.00	0.24	0.15	0.02	0.01	0.02	0.01	0.00	0.19	0.73	2.93
Batteries and accumulators wastes	EWC_0841	0.00	0.00	0.02	0.00	0.05	0.02	0.02	0.20	0.01	0.00	0.00	0.05	0.05	0.17
Animal waste of food preparation and products	EWC_0911	0.05	0.00	0.58	0.01	0.70	0.07	3.19	0.32	0.03	0.03	0.05	0.43	0.15	2.13
Animal faeces, urine and manure	EWC_093	1.42	0.00	1.54	0.00	0.74	0.30	96.93	0.14	2.20	0.16	0.66	0.18	0.10	0.12
Animal and vegetal wastes (excluding animal waste of food preparation and products; and animal faeces, urine and manure)	EWC_09_NOT_0911_093	0.70	0.09	1.24	0.00	9.88	1.67	22.25	0.73	9.58	0.11	0.52	0.46	4.51	9.78
Household and similar wastes	EWC_101	1.29	0.67	4.11	0.24	8.03	2.46	7.20	6.65	2.40	0.85	1.44	1.93	2.67	47.75
Mixed and undifferentiated materials	EWC_102	0.01	0.01	0.23	0.01	0.40	1.19	0.35	0.78	3.32	0.19	0.08	0.55	2.46	7.40
Sorting residues	EWC_103	0.01	0.76	0.14	0.02	1.06	0.57	1.35	0.42	0.03	0.05	0.14	0.41	1.28	4.78
Dredging spoils	EWC_113	0.00	0.00	0.00	0.00	25.21	0.00	0.23	0.00	0.00	0.32	3.10	0.00	0.14	15.35
Common sludges (excluding dredging spoils)	EWC_11_NOT_113	0.10	0.01	0.42	0.00	0.61	0.27	3.86	0.89	0.17	0.07	0.29	0.68	0.48	2.03
Mineral wastes (excluding combustion wastes, contaminated soils and polluted dredging spoils)	EWC_121_TO_125_NOT_124	0.72	6.95	5.53	2.50	30.53	30.99	92.45	9.29	295.4	1.21	1.51	45.93	70.14	178.23
Combustion wastes	EWC_124	0.01	0.52	4.20	0.00	5.14	1.23	27.64	0.19	11.35	0.85	3.89	3.00	3.11	8.10

Contaminated soils and polluted dredging spoils	EWC_126	0.02	0.04	0.73	0.00	1.16	0.15	0.09	0.01	0.00	0.01	0.18	0.39	0.42	0.20
Solidified, stabilised or vitrified wastes	EWC_13	0.00	0.00	0.02	0.00	0.00	0.16	0.04	0.00	0.00	0.00	0.26	0.03	0.04	0.10
Total Waste		**7.7**	**9.6**	**22.3**	**2.9**	**93.4**	**48.2**	**269.7**	**38.7**	**331.9**	**6.1**	**14.5**	**72.2**	**115.0**	**346.1**

Table 69: Estimated Total Waste Generation in the year 2006 in EU 27 in million tonnes (Mt) by EWC-Stat Category and economic branch (derived from Eurostat 2009a)

Waste category	NACE - Branch	A	B	C	DA	DB_DC	DD	DE	DF	DG_DH	DI	DJ	DK_TO_DM
EWCStat-Name	EWCStat-#	Agriculture, hunting and forestry	Fishing	Mining and quarrying	Manufacture of food products; beverages and tobacco	Manufacture of textiles and textile products, leather and leather products	Manufacture of wood and wood products	Manufacture of pulp, paper and paper products; publishing and printing	Manufacture of coke, refined petroleum products and nuclear fuel	Manufacture of chemicals, rubber and plastic products	Manufacture of other non-metallic mineral products	Manufacture of basic metals and fabricated metal products	Manufacture of machinery and equipment n.e.c., electrical and optical equipment, transport equipment
Spent solvents	EWC_011	0.01	0.00	0.00	0.01	0.02	0.00	0.05	0.01	1.97	0.01	0.05	0.10
Acid, alkaline or saline wastes	EWC_012	0.00	0.00	0.01	0.03	0.00	0.00	0.49	0.48	2.44	0.11	2.72	0.44
Used oils	EWC_013	0.15	0.01	0.14	0.06	0.01	0.01	0.02	0.09	0.16	0.04	0.76	0.78
Spent chemical catalysts	EWC_014	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.07	0.06	0.00	0.00	0.00
Chemical preparation wastes	EWC_02	0.04	0.00	0.01	0.43	0.30	0.61	0.31	0.09	2.27	0.08	0.35	0.36
Chemical deposits and residues	EWC_031	0.23	0.00	0.26	0.28	1.38	0.02	0.76	1.26	7.39	0.22	2.01	0.61
Industrial effluent sludges	EWC_032	0.03	0.00	0.46	0.30	0.24	0.01	1.60	0.57	1.70	0.22	1.29	0.35
Health care and biological wastes	EWC_05	0.07	0.00	0.00	0.05	0.00	0.00	0.00	0.00	0.02	0.00	0.00	0.00
Metallic wastes	EWC_06	0.15	0.01	0.58	0.38	0.12	0.21	0.52	0.13	0.60	1.23	16.97	12.19
Glass wastes	EWC_071	0.08	0.00	0.00	0.65	0.01	0.02	0.04	0.00	0.07	1.29	0.06	0.16
Paper and cardboard wastes	EWC_072	0.05	0.00	0.01	1.82	0.31	0.10	11.68	0.01	0.75	0.19	0.40	1.31
Rubber wastes	EWC_073	0.20	0.00	0.03	0.01	0.01	0.01	0.01	0.00	0.28	0.01	0.03	0.04
Plastic wastes	EWC_074	0.73	0.01	0.01	0.56	0.16	0.05	0.30	0.01	1.68	0.07	0.14	0.43
Wood wastes	EWC_075	2.10	0.00	0.03	0.33	0.06	42.36	9.86	0.01	0.46	0.17	0.31	0.94
Textile wastes	EWC_076	0.00	0.00	0.00	0.01	2.12	0.00	0.01	0.00	0.05	0.00	0.01	0.05
Waste containing PCB	EWC_077	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.05	0.00	0.01	0.00
Discarded equipment (excluding vehicles & batteries)	EWC_080_NOT_081_0841	0.05	0.00	0.01	0.02	0.00	0.00	0.02	0.00	0.03	0.02	0.06	0.13
Discarded vehicles	EWC_081	0.35	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.04	0.04
Batteries and accumulators wastes	EWC_0841	0.04	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.10
Animal waste of food preparation and products	EWC_0911	2.88	0.02	0.00	8.14	0.05	0.00	0.00	0.00	0.07	0.00	0.00	0.00
Animal faeces, urine and manure	EWC_093	123.80	0.00	0.00	0.99	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Other animal and vegetal wastes	EWC_09_NOT_0911_093	29.76	0.40	0.01	29.16	0.03	0.03	0.02	0.02	0.55	0.01	0.02	0.05
Household and similar wastes	EWC_101	0.40	0.04	0.06	1.66	0.46	0.43	1.02	0.05	1.32	0.44	0.97	1.96
Mixed and undifferentiated materials	EWC_102	0.05	0.00	0.10	2.55	0.50	0.49	0.90	0.23	2.29	1.18	1.83	1.36
Sorting residues	EWC_103	0.01	0.00	0.01	0.06	0.02	0.01	2.82	0.00	0.11	0.08	0.21	0.06
Dredging spoils	EWC_113	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.02	0.01	0.01
Common sludges (excluding dredging spoils)	EWC_11_NOT_113	0.47	0.02	0.11	1.46	0.25	0.02	2.04	0.02	0.06	0.03	0.04	0.04
Mineral wastes (excluding combustion wastes, contaminated soils &polluted dredging spoils)	EWC_121_TO_125_NOT_124	0.28	0.00	736.73	10.59	0.03	0.17	0.51	0.38	12.57	19.23	46.11	1.86

Combustion wastes	EWC_124	0.02	0.01	5.07	0.39	0.02	0.46	0.99	0.04	1.38	1.05	37.15	0.49
Contaminated soils and polluted dredging spoils	EWC_126	0.00	0.00	0.13	0.03	0.00	0.00	0.00	0.24	0.10	0.02	0.13	0.02
Solidified, stabilised or vitrified wastes	EWC_13	0.07	0.00	0.00	0.00	0.00	0.01	0.09	0.00	0.96	0.11	0.11	0.01
Total Waste		**162.0**	**0.5**	**743.8**	**60.0**	**6.1**	**45.0**	**34.1**	**3.7**	**39.4**	**25.9**	**111.8**	**23.9**

Waste category	NACE - Branch	DN36	DN37	DN37 +G5157 +O90	D NOT_DN37	E	F	G5157	G_TO_Q_ NOT_G5157 _O90	HH	O90	TOT_NACE + HH
EWCStat-Name	EWCStat-#	Manufacture of furniture; manufacturing n.e.c.	Recycling	Waste management activities	Manufacturing excluding recycling	Electricity, gas and water supply	Construction	Wholesale of waste and scrap	Other economic activities (services) excluding 51.57 and 90	Households	Sewage and refuse disposal, sanitation and similar activities	All NACE branches plus households
Spent solvents	EWC_011	0.03	0.02	0.29	2.25	0.02	0.02	0.04	0.23	0.03	0.23	2.9
Acid, alkaline or saline wastes	EWC_012	0.13	0.09	0.40	6.84	0.11	0.02	0.02	0.67	0.01	0.29	8.1
Used oils	EWC_013	0.01	0.12	0.70	1.95	0.04	0.53	0.09	2.91	0.05	0.49	6.5
Spent chemical catalysts	EWC_014	0.00	0.00	0.01	0.14	0.00	0.00	0.01	0.02	0.00	0.00	0.2
Chemical preparation wastes	EWC_02	0.06	0.20	1.20	4.87	0.01	0.08	0.07	0.84	0.11	0.93	7.2
Chemical deposits and residues	EWC_031	0.05	0.17	1.41	13.98	1.10	0.54	0.13	3.13	0.01	1.11	20.7
Industrial effluent sludges	EWC_032	0.02	0.17	2.20	6.30	0.96	0.11	0.05	0.96	0.00	1.98	11.0
Health care and biological wastes	EWC_05	0.00	0.00	0.02	0.08	0.00	0.01	0.00	2.19	0.00	0.02	2.4
Metallic wastes	EWC_06	0.39	24.74	41.58	32.74	0.54	11.64	14.22	11.89	3.37	2.62	102.5
Glass wastes	EWC_071	0.02	0.61	1.27	2.31	0.01	0.54	0.04	3.98	7.23	0.61	15.4
Paper and cardboard wastes	EWC_072	0.26	0.82	3.84	16.82	0.13	1.58	1.00	25.06	16.68	2.02	64.2
Rubber wastes	EWC_073	0.01	0.51	0.68	0.41	0.00	0.05	0.03	2.22	0.16	0.14	3.8
Plastic wastes	EWC_074	0.09	0.93	1.35	3.49	0.02	2.79	0.07	5.03	2.17	0.34	15.6
Wood wastes	EWC_075	1.99	3.10	4.81	56.51	1.43	14.08	0.11	3.89	3.34	1.60	86.2
Textile wastes	EWC_076	0.02	0.10	0.16	2.28	0.00	0.01	0.02	0.56	0.79	0.04	3.8
Waste containing PCB	EWC_077	0.00	0.01	0.02	0.07	0.01	0.01	0.00	0.01	0.00	0.01	0.1
Discarded equipment (excluding vehicles & batteries)	EWC_080_NOT_081_0841	0.01	0.41	0.96	0.30	0.06	0.07	0.28	1.08	0.94	0.27	3.5
Discarded vehicles	EWC_081	0.08	4.77	5.22	0.18	0.01	0.04	0.36	6.49	1.89	0.09	14.2
Batteries and accumulators wastes	EWC_0841	0.00	0.13	0.41	0.14	0.01	0.02	0.16	0.88	0.11	0.11	1.6
Animal waste of food preparation and products	EWC_0911	0.00	0.33	0.41	8.27	0.00	0.00	0.01	1.40	0.09	0.08	13.1
Animal faeces, urine and manure	EWC_093	0.00	0.00	0.09	0.99	0.08	0.00	0.00	0.22	0.00	0.09	125.2
Other animal and vegetal wastes	EWC_09_NOT_0911_093	0.03	0.10	2.80	29.91	0.13	0.60	0.02	10.17	23.26	2.68	97.0
Household and similar wastes	EWC_101	0.64	0.55	6.55	8.95	0.39	1.13	0.55	40.89	146.12	5.44	204.5
Mixed and undifferentiated materials	EWC_102	0.51	1.87	3.92	11.85	0.15	13.91	0.20	7.57	6.24	1.85	43.8
Sorting residues	EWC_103	0.00	15.13	31.35	3.37	0.43	0.82	1.61	0.56	0.04	14.61	36.6
Dredging spoils	EWC_113	0.00	0.07	0.30	0.04	0.25	43.00	0.03	2.78	0.02	0.20	46.4
Common sludges (excluding dredging spoils)	EWC_11_NOT_113	0.01	0.03	9.11	3.97	2.86	0.14	0.02	0.51	0.17	9.06	17.4
Mineral wastes (excluding combustion wastes, contaminated soils and polluted dredging spoils)	EWC_121_TO_125_NOT_124	0.08	10.29	22.58	91.53	95.46	871.02	1.70	10.89	4.89	10.59	1,833.4
Combustion wastes	EWC_124	0.26	0.80	10.59	42.23	90.05	0.30	0.85	5.82	0.28	8.93	154.4
Contaminated soils and polluted dredging spoils	EWC_126	0.00	0.04	1.01	0.54	0.07	7.23	0.61	0.46	0.00	0.36	9.4
Solidified, stabilised or vitrified wastes	EWC_13	0.00	0.36	1.43	1.29	0.39	0.02	0.03	0.25	0.00	1.04	3.5
Total Waste		**4.7**	**66.5**	**156.7**	**354.6**	**194.7**	**970.3**	**22.3**	**153.6**	**218.0**	**67.8**	**2,954.2**

Table 70: Treatment of Waste in the year 2006 in EU 27 in million tonnes (Mt) by EWC-Stat Category a (derived from Eurostat 2009a)

EWCStat-Name	EWCStat-#	Deposit onto or into land	Disposal	Incineration	Land treatment and release into water bodies	Recovery	Energy recovery	Total treated
Used oils	EWC_013	0.18	0.18	0.30	0.01	3.00	0.51	
Chemical wastes (Chemical compound waste + Chemical preparation wastes + Other chemical wastes)	EWC_01_TP_03	8.76	8.18	0.60	1.50	0.00	2.39	
Chemical wastes excluding Used oils (Chemical compound waste + Chemical preparation wastes + Other chemical wastes)	EWC_01_TO_03 NOT_013	4.23	4.61	3.53	0.51	0.00	2.91	
Health care and biological wastes	EWC_05	0.00	0.00	0.69	0.00	0.00	0.15	
Metallic wastes	EWC_06	0.00	0.00	0.00	0.00	74	0.00	
Glass wastes	EWC_071	0.00	0.00	0.00	0.00	11	0.00	
Paper and cardboard wastes	EWC_072	0.00	0.00	0.00	0.00	35	0.00	
Rubber wastes	EWC_073	0.00	0.00	0.00	0.00	2	0.00	
Plastic wastes	EWC_074	0.00	0.00	0.00	0.00	6	0.00	
Wood wastes	EWC_075	0.00	0.00	0.00	0.00	36	0.00	
Textile wastes	EWC_076	0.00	0.00	0.00	0.00	3	0.00	
Waste containing PCB	EWC_077	0.00	0.00	0.03	0.00	0.00	0.00	
Animal waste of food preparation and products	EWC_0911	153	153	0.00	0.02	2	0.00	
Animal faeces, urine and manure	EWC_093	0.33	0.44	0.00	0.11	9	0.00	
Animal and vegetal wastes (excluding animal waste of food preparation and products; and animal faeces, urine and manure)	EWC_09_ NOT_0911_093	4.85	5.23	0.00	0.38	43	0.00	
Household and similar wastes	EWC_101	106	106	35	0.38	0.00	13	
Mixed and undifferentiated materials	EWC_102	13	12	1.73	0.31	0.00	2.00	
Sorting residues	EWC_103	21	19	3.01	0.03	0.00	4.55	
Common sludges (including dredging spoils)	EWC_11	7.41	38	1.60	30	0.00	1.74	
Mineral wastes (excluding combustion wastes, contaminated soils and polluted dredging spoils)	EWC_121_TO_125 NOT_124	982	976	0.00	6.38	788	0.00	
Unclear		10	26	4.93	0.07	124	49	
Total Waste Treated	**EWC_01_TO_13**	**1,310**	**1,349**	**51**	**40**	**1,137**	**77**	**2,599**

Annex 3: Transboundary Wase Flow Data EU27

Table 71: Export of the 18 largest hazardous waste streams exported from 27 EU Member States by the targeted disposal - amount in thousand tonnes (kt) (ETC-SCP 2009)

For the definition of the D codes see Table 74.

Waste type according European Waste List (EWL)	EWL code	**D1**	**D3**	**D5**	**D8**	**D9**	**D10**	**D12**	**D13**	**D14**	**D15**	**Total**
wastes marked as hazardous, partly stabilised	190304	227.8				9.3	5.3					**242.4**
soil and stones containing dangerous substances	170503	76.6		47.4	66.9	27.5	7.1	0.2	1.8		4.4	**231.9**
premixed wastes composed of at least one hazardous waste	190204	82.9				1.6	81.7	3.1		11.1		**180.4**
construction materials containing asbestos	170605	122.9		1.7				0.1				**124.7**
fly ash	190113		0.3	2.9		14.2		61.6		7.2		**86.2**
other wastes from mechanical treatment of waste containing dangerous substances	191211	7.6		9.5			37.8					**54.9**
sludges from physico/chemical treatment containing dangerous substances	190205	2.2					28.9	2.8	0.9			**34.8**
halogenated still bottoms and reaction residues	70107						33.6					**33.6**
other still bottoms and reaction residues	70108					20.5	13.1					**33.6**
solid wastes from gas treatment (iron industry)	100207	15.1				8		0.8				**23.9**
slags from lead thermal metallurgy	100401	7.1		8				8.4				**23.5**
fluff-light fraction and dust containing dangerous substances	191003			17.6			5.6					**23.2**
waste paint	80111		0.9				15.9		4.9			**21.7**
insulation materials containing asbestos	170601	18.5					0.7					**19.2**
oily water from oil/water separators	130507					3.6	9.6					**13.2**
sludges containing dangerous substances from other treatment of industrial waste water	190813	2		0.1		0.6	5.6	0.2	4.5			**13**
sludges containing dangerous substances from biological treatment of industrial waste water	190811						12.7					**12.7**
aqueous washing liquids (from organic chemical processes)	70101					1.6	10.1					**11.7**
Total top 18		**562.7**	**1.2**	**87.2**	**66.9**	**86.9**	**267.7**	**77.2**	**12.1**	**18.3**	**4.4**	**1,185**
Total all hazardous waste		**613.7**	**1.2**	**88.2**	**69.5**	**137.1**	**450.4**	**90.7**	**16.2**	**19.6**	**5.2**	**1,492**
Share in % on total haz. waste exports		*13.5*	*0.0*	*1.9*	*1.5*	*3.0*	*9.9*	*2.0*	*0.4*	*0.4*	*0.1*	*32.9*

Table 72: Export of the 19 largest hazardous waste streams exported from 27 EU Member States by the targeted recovery operation - amount in thousand tonnes (kt) (ETC-SCP 2009)

For the definition of the R codes see Table 74.

		Recovery operation														
Waste type according European Waste List (EWL)	EWL code	**R**	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**	**R10**	**R11**	**R12**	**R13**	**Total**
soil and stones containing dangerous substances	170503						412.4					0.1	12	23.3		**447.8**
solid wastes from gas treatment (iron industry)	100207					241.9	2.1				5.4			1.1		**250.5**
lead batteries	160601					220.6								0.1	0.1	**220.8**
glass, plastic and wood containing or contaminated with dangerous substances	170204		92.8		22.4									1.9	32.6	**149.7**
other sludges from physico/chemical treatment	191206		113.3		3.1					3				2.9	4.6	**126.9**
salt slags from secondary aluminum production	100308					14.5	108.5									**123**
fly ash containing dangerous substances	190113						121.4									**121.4**
mineral-based non-chlorinated engine, gear and lubricating oils	130205		4								110.8				5.1	**119.9**
pickling acids	110105				0.2	44.6	3.6	17.7					1.6	0.1	0.7	**68.5**
solid wastes from gas treatment	190107						56.2									**56.2**
sludges from physico/chemical treatment containing dangerous substances	190205					36.1	15.2							2.1	1.4	**54.8**
other organic solvents, washing liquids and mother liquors	70104		34.1	16.1	1.3									1.4	0.6	**53.5**
other still bottoms and reaction residues	70108		27.3	5.5	15.1		3.6				0.5					**52**
hazardous components removed from discarded electric/electronic equipment	160215		0.6		0.2	1.5	42.8							2.7		**47.8**
bilge oils from other navigation	130403	0.7	38.7		1.6						2.5				2.1	**45.6**
filter cake from gas treatment	190105					1.3	43.7									**45**
other organic solvents, washing liquids and mother liquors	70504		16.7	24.8	0.7											**42.2**
other engine, gear and lubricating oils	130208										41.7					**41.7**
premixed wastes composed of at least one hazardous waste	190204		7.2		2.2	0.7	4		3.8				18.2	0.8	3.6	**40.5**
Total top 19		**0.7**	**334.7**	**46.4**	**46.8**	**561.2**	**813.5**	**17.7**	**3.8**	**3**	**160.9**	**0.1**	**31.8**	**36.4**	**50.8**	**2,108**
Total all hazardous waste		**2**	**465.6**	**86.9**	**113.6**	**858.8**	**1006.3**	**44.7**	**13.7**	**18.2**	**232.8**	**0.2**	**43**	**80.9**	**73.8**	**3,041**
Share in % on total haz. waste exports		*0.0*	*10.3*	*1.9*	*2.5*	*18.9*	*22.2*	*1.0*	*0.3*	*0.4*	*5.1*	*0.0*	*0.9*	*1.8*	*1.6*	*67.1*

Table 73: Export of the 20 largest notified non-hazardous waste types in 2007 from 27 EU Member States by targets disposal/recovery operation in thousand tonnes (kt) (ETC-SCP 2009)

For the definition of the D and R codes see Table 74.

		Disposal operation					**Recovery operation**							
Waste type according European Waste List (EWL)	EWL code	**D1**	**D8**	**D9**	**D10**	**Mix**	**R1**	**R3**	**R4**	**R5**	**R12**	**R13**	**Not specified**	**Total**
wood (from mechanical treatment)	191207				4.0		529.0	416.8			15.5	21.4		986.7
combustible waste (from mechanical treatment)	191210				3.1	0.7	564.5	4.5			0.2	11.2		584.2

other wastes from mechanical treatment	191212	0.1			60.7	12.7	205.0	36.2	17.3	33.7	46.0	42.4		454.1
mixed municipal waste	200301	2.8			198.1	2.7	52.1	23.3			0.7	61.6		341.3
wood (C&D waste)	170201	0.9					73.7	205.9		2.7	23.7	2.0		308.9
sludges from treatment of urban waste water	190805				195.9		51.8	36.9		0.2	0.1	1.8	9.7	296.4
bottom ash and slag (from waste treatment)	190112	37.3				1.7			0.2	169.3	25.7		12.2	246.4
soil and stones	170504	38.4	8.5	20.9					23.6	135.3	12.0		0.7	239.4
animal faeces, urine and manure	20106							204.1					17.7	221.8
unspeicified	999990	0.3	3.3	114.7	8.0	14.0	2.0	8.3	25.1	14.2	2.6	2.6	16.5	211.6
minerals (from mechanical treatment)	191209									164.7	13.6	6.5		184.8
sawdust, shavings, cuttings, wood	30105						2.1	112.4			34.0		14.0	162.5
fibre rejects, fibre-, filler- and coating-sludges from mechanical separation	30310				11.4	24.0	9.8	56.2		22.2				123.6
non-ferrous waste (from shredders)	191002					9.6			82.9			19.1	0.7	112.3
non-composted fraction of municipal and similar wastes	190501						109.2	2.1				0.6		111.9
sludges from on-site effluent treatment	20204		78.6	15.2				7.6			5.2		1.2	107.8
sludges and filter cakes from gas treatment, iron industry	100214								77.7		26.1			103.8
wood from MSW	200138						61.6	25.5			9.6	2.4		99.1
unprocessed iron slag	100202									98.7				98.7
animal-tissue waste	20202	0.2					63.3	4.2					14.0	81.7
Total top 20		**80.0**	**90.4**	**150.8**	**481.2**	**65.4**	**1,724**	**1,144**	**226.8**	**641.0**	**215.0**	**171.6**	**86.7**	**5,077**
Share in %		*1.6*	*1.8*	*3.0*	*9.5*	*1.3*	*34.0*	*22.5*	*4.5*	*12.6*	*4.2*	*3.4*	*1.7*	*100.0*

Table 74: R and D codes according to EU Waste Framework Directive

Code	**Definition**
Disposal operations	
D1	Deposit into or onto land (e.g. landfill)
D2	Land treatment
D3	Deep injection
D4	Surface impoundment (e.g. placement in lagoons)
D5	Specially engineered landfill
D6	Release into water body (except seas/oceans)
D7	Release into seas/oceans
D8	Biological treatment which results in compounds which are discarded
D9	Physico/chemical treatment which results in compounds which are discarded
D10	Incineration on land
D11	Incineration at sea
D12	Permanent storage
D13	Blending or mixing prior to other D operations
D14	Repackaging prior to other D operations

D15	Storage in connection with D operations
Recovery and recycling operations	
R1	Use as a fuel
R2	Solvent reclamation/regeneration
R3	Recycling/reclamation of organic substances which are not used as solvents
R4	Recycling/reclamation of metals and metal compounds
R5	Recycling/reclamation of other inorganic materials
R6	Regeneration of acids or bases
R7	Recovery of components used for pollution abatement
R8	Recovery of components from catalysts
R9	Used oil re-refining or other reuses of previously used oil
R10	Land treatment resulting in benefit to agriculture or ecological improvement
R11	Uses of residual materials from R1 to R10 operations
R12	Exchange of wastes for submission to R1 to R11 operations
R13	Accumulation of material for submission to R1 to R12 operations

Annex 4: Material Flow Data EU27

Table 75: Domestic Extraction in EU 27 in Mt

Derived from EUROSTAT, Questionnaire on Economy wide material flow accounts (EW MFA) from 04.02.2009; submitted on 22.01.2010)

Year	2000	2001	2002	2003	2004	2005	Average increase in %/a for the period 2000 to 2005
A.1 Biomass	**1,616**	**1,570**	**1,588**	**1,469**	**1,656**	**1,591**	**-0.3**
A.1.1 Primary crops	680	664	678	618	723	666	-0.4
A.1.1.1 Cereals	277	285	289	252	325	289	0.8
A.1.1.2 Roots, tubers	84	75	73	64	72	63	-5.6
A.1.1.3 Sugar crops	139	126	144	124	135	132	-1.0
A.1.1.4 Pulses	4.6	4.7	4.8	4.7	5.1	4.1	-2.4
A.1.1.5 Nuts	0.8	0.8	0.8	0.7	0.6	0.8	0.1
A.1.1.6 Oil bearing crops	30	32	30	33	37	36	3.6
A.1.1.7 Vegetables	66	65	63	66	68	66	-0.1
A.1.1.8 Fruits	71	68	66	66	72	66	-1.5
A.1.1.9 Fibres	0.8	0.7	0.9	0.9	1.0	1.0	5.8
A.1.1.10 Other crops (Spices Stimulant crops, Tobacco, Rubber and other crops)	6.5	7.1	7.2	6.3	8.1	8.3	5.1
A.1.2 Crop residues (used)	148	149	156	138	170	153	0.7
A.1.2.1 Straw	114	118	121	107	137	121	1.2
A.1.2.2 Other crop residues (sugar and fodder beet leaves, other)	34	31	35	31	33	32	-1.0
A.1.3 Fodder crops incl grassland harvest	319	312	309	267	299	290	-1.9
A.1.3.1 Fodder crops	172	174	172	164	161	160	-1.4
A.1.3.2 Biomass harvested from grassland	147	138	137	102	139	130	-2.4
A.1.4 Grazed biomass	212	207	202	193	205	206	-0.6
A.1.5 Wood	248	230	236	247	251	269	1.6
A.1.5.1 Timber (Industrial roundwood)	192	175	177	185	189	207	1.5
A.1.5.2 Wood fuel and other extraction	27	27	27	30	30	31	2.7
A.1.6 Fish capture, crustaceans, molluscs and aquatic invertebrates	8.6	8.7	8.0	7.2	6.9	6.9	-4.2
A.1.7 Hunting and gathering	0.3	0.3	0.4	0.3	0.3	0.3	-0.5
A.2 Metal ores (gross ores)	**126**	**120**	**118**	**121**	**123**	**125**	**-0.2**
A.2.1 Iron ores	26	24	25	27	28	28	1.6
A.2.2 Non ferrous metal ores	97	93	90	89	91	92	-0.9
A.2.2.1.a Copper ores gross ore	53	56	55	55	57	59	1.9
A.2.2.1.b Copper ores metal content	0.2	0.2	0.2	0.2	0.2	0.2	1.5
A.2.2.2.a Nickel ores gross ore	2.4	2.6	2.8	2.7	2.7	2.8	3.1
A.2.2.2.b Nickel ores metal content							
A.2.2.3.a Lead ores gross ore	6.1	6.0	4.7	4.9	4.8	4.9	-4.1
A.2.2.3.b Lead ores metal content	0.1	0.1	0.1	0.1	0.1	0.1	6.8
A.2.2.4.a Zinc ores gross ore	8.6	7.5	6.4	7.0	6.8	7.1	-3.8
A.2.2.4.b Zinc ores metal content	0.3	0.2	0.3	0.4	0.5	0.5	10.6
A.2.2.5.a Tin ores gross ore	6.8	2.7	1.7	1.5	0.0	0.0	-85.7
A.2.2.5.b Tin ores metal content							
A.2.2.6.a Gold, silver, platinum and other precious metal ores gross ore	12	13	13	13	14	14	3.0

Year	2000	2001	2002	2003	2004	2005	Average increase in %/a for the period 2000 to 2005
A.2.2.6.b Gold, silver, platinum and other precious metal ores metal content	0.0	0.0	0.0	0.0	0.0	0.0	-15.2
A.2.2.7.a Bauxite and other aluminium ores gross ore	3.1	3.0	3.3	3.2	3.1	3.1	-0.4
A.2.2.7.b Bauxite and other aluminium ores metal content							
A.2.2.8.a Uranium and thorium ores gross ore	0.8	0.4	0.3	0.2	0.2	0.1	-36.2
A.2.2.8.b Uranium and thorium ores metal content	0.0	0.0	0.0	0.0	0.0	0.0	
A.2.2.9.a Other metal ores gross ore	3.5	1.7	2.7	2.6	2.5	2.4	-6.9
A.2.2.9.b Other metal ores metal content							
A.3 Non metalic minerals	**3,640**	**3,654**	**3,583**	**3,599**	**3,706**	**3,823**	**1.0**
A.3.1 Ornamental or building stone	183	151	162	180	201	218	3.6
A.3.2 Limestone, gypsum, chalk, and dolomite	621	625	653	674	715	721	3.0
A.3.3 Slate	3	3	2	2	2	2	-5.2
A.3.4 Gravel and sand	2,572	2,607	2,498	2,465	2,504	2,593	0.2
A.3.5 Clays and kaolin	124	126	120	119	123	124	-0.1
A.3.6 Chemical and fertilizer minerals	11	10	9	10	10	6	-10.8
A.3.7 Salt	52	53	53	55	58	59	2.7
A.3.8 Other mining and quarrying products n.e.c.	53	55	57	59	61	64	4.0
A.3.9 Excavated soil, only if used (e.g for construction work)	22	25	29	35	31	35	9.4
A.4 Fossil energy carriers	**1,033**	**1,030**	**1,027**	**1,014**	**992**	**949**	**-1.7**
A.4.1 Brown coal incl. oil shale and tar sands	437	451	455	459	457	448	0.5
A.4.2 Hard coal	206	198	192	187	182	170	-3.8
A.4.3 Petroleum	165	155	158	148	137	124	-5.5
A.4.4 Natural gas	211	211	206	203	205	190	-2.1
A.4.5 Peat	13	15	17	16	12	16	4.5

Table 76: Imports to EU area (EU-27) in Mt

Derived from EUROSTAT, Questionnaire on Economy wide material flow accounts (EW MFA) from 04.02.2009; submitted on 22.01.2010)

Year	2000	2001	2002	2003	2004	2005	Average increase in %/a for the period 2000 to 2005
B.1 Biomass and biomass products	**171**	**174**	**184**	**186**	**162**	**163**	**-1.0**
B.1.1 primary crops	49.9	56.3	62.3	59.0	58.6	57.1	2.7
B.1.1.1 Cereals, primary and processed	9.6	11.6	18.6	14.3	15.7	14.1	8.0
B.1.1.2 Roots and tubers, primary and processed	1.3	1.2	1.0	1.2	1.4	1.1	-4.1
B.1.1.3 Sugar crops, primary and processed	5.4	5.2	5.6	5.5	5.3	4.6	-3.1
B.1.1.4 Pulses, primary and processed	0.6	0.6	0.4	0.3	0.5	0.8	6.3

Year	2000	2001	2002	2003	2004	2005	Average increase in %/a for the period 2000 to 2005
B.1.1.5 Nuts, primary and processed	0.3	0.4	0.5	0.5	0.5	0.5	7.9
B.1.1.6 Oil bearing crops, primary and processed	13	17	15	15	12	13	0.1
B.1.1.7 Vegetables, primary and processed	3.8	4.1	4.0	4.6	4.8	4.5	3.6
B.1.1.8 Fruits, primary and processed	9.0	9.2	9.5	10.2	10.8	10.8	3.7
B.1.1.9 Fibres, primary and processed	1.5	1.4	1.4	1.2	1.1	1.0	-7.5
B.1.1.10 Other crops (Spices Stimulant crops, Tobacco, Rubber and other crops), primary and processed	5.2	5.6	5.4	5.5	5.7	5.8	2.1
B.1.2 Crop residues	28	30	31	31	30	31	1.8
B.1.2.1 n.a.							
B.1.2.2 Other crop residues (sugar and fodder beet leaves, other)	28	30	30	31	30	31	1.7
B.1.3 Fodder crops incl grassland harvest	0.7	0.5	0.4	0.3	0.3	0.3	-19.2
B.1.3.1 Fodder crops	0.7	0.5	0.4	0.3	0.3	0.3	-19.2
B.1.3.2 Biomass harvested from grassland							
B.1.4 n.a.							
B.1.5 Wood primary and processed	50	48	50	51	32	35	-6.9
B.1.5.1 Timber, primary and processed	42	40	42	43	24	26	-8.9
B.1.5.2 Wood fuel and other extraction, primary and processed	7.3	7.6	7.9	9.0	8.3	8.3	2.6
B.1.6 Fish capture, crustaceans, molluscs and aquatic invertebrates primary and processed	3.7	4.0	4.1	4.5	4.3	4.3	3.1
B.1.7 n.a.							
B.1.8 Live animals other than in B 1.6., meat and meat products	4.0	4.2	4.1	4.2	4.0	4.2	1.2
B.1.8.1 Live animals other than in B 1.6.	0.0	0.0	0.0	0.0	0.0	0.0	-14.3
B.1.8.2 Meat and meat preparations	0.9	1.2	1.2	1.3	1.3	1.5	10.5
B.1.8.3 Dairy products, birds eggs, and honey	0.5	0.5	0.5	0.5	0.5	0.5	-0.6
B.1.8.4 Other products from animals (animal fibres, skins, furs, leather etc.)	2.7	2.8	2.6	2.6	2.7	2.7	-0.6
B.1.9 Products mainly from biomass	35	32	35	38	35	35	-0.1
B.2 Metal ores and concentrates, processed metals	**205**	**199**	**198**	**216**	**231**	**226**	**1.9**
B.2.1 Iron ores and concentrates, iron and steel	145	136	137	149	159	153	1.1
B.2.2 non ferrous metal ores and concentrates, processed metals	36	36	34	35	37	36	0.1
B.2.2.1 Copper	4.1	4.6	4.4	4.1	4.7	4.7	2.7
B.2.2.2 Nickel	0.3	0.3	0.3	0.2	0.2	0.2	-4.7
B.2.2.3 Lead	0.7	0.6	0.6	0.5	0.6	0.5	-4.4
B.2.2.4 Zinc	2.0	1.9	1.7	1.6	1.4	1.6	-4.9
B.2.2.5 Tin	0.06	0.06	0.06	0.06	0.06	0.06	0.5
B.2.2.6 Gold, silver, platinum and other precious metals	0.04	0.02	0.02	0.02	0.06	0.08	17.4
B.2.2.7 Aluminium	20	21	20	21	22	22	1.7
B.2.2.8 Uranium and thorium	0.002	0.002	0.000	0.001	0.000	0.000	
B.2.2.9 Other metals	7.1	6.0	5.5	5.9	6.3	5.2	-5.9
B.2.3 Products mainly from metals	23	24	24	29	32	33	8.2

Year	2000	2001	2002	2003	2004	2005	Average increase in %/a for the period 2000 to 2005
B.3 Non metalic minerals primary and processed	**104**	**110**	**109**	**114**	**110**	**109**	**1.0**
B.3.1 Ornamental or building stone	6.2	6.8	7.5	7.6	8.4	8.6	6.7
B.3.2 Limestone, gypsum, chalk, and dolomite	4.5	4.5	4.5	4.6	2.0	2.4	-11.5
B.3.3 Slate	0.01	0.02	0.02	0.02	0.02	0.02	8.2
B.3.4 Gravel and sand	28	31	31	32	34	34	3.9
B.3.5 Clays and kaolin	5.8	6.5	6.1	6.5	7.3	7.6	5.6
B.3.6 Chemical and fertilizer minerals	25	24	22	23	20	18	-6.4
B.3.7 Salt	0.7	1.0	1.1	1.4	1.9	2.4	27.2
B.3.8 Other mining and quarrying products n.e.c.	21	22	22	22	18	18	-3.1
B.3.9 Excavated soil, only if used (e.g for construction work)							
B.3.10 Products mainly from non metalic minerals	12	13	15	17	17	16	7.1
B.4 Fossil energy carriers, primary and processed	**924**	**949**	**957**	**1,028**	**1,053**	**1,088**	**3.3**
B.4.1 Brown coal incl. oil shale and tar sands	0.8	1.0	1.2	1.8	1.8	1.3	9.8
B.4.2 Hard coal	133	144	136	148	160	161	3.9
B.4.3 Petroleum	581	598	593	624	512	535	-1.7
B.4.4 Natural gas	172	172	188	210	213	223	5.3
B.4.5 Peat	0.4	0.5	0.7	0.9	0.2	0.1	-23.4
B.4.6 Products mainly from fossil energy carriers	32	33	36	41	34	34	1.0
B.5 Other products	**25**	**26**	**26**	**29**	**31**	**31**	**4.9**

Table 77: Exports from EU area (EU-27) in Mt

Derived from EUROSTAT, Questionnaire on Economy wide material flow accounts (EW MFA) from 04.02.2009; submitted on 22.01.2010

Year	2000	2001	2002	2003	2004	2005	Average increase in %/a for the period 2000 to 2005
D.1 Biomass and biomass products	**125**	**115**	**123**	**131**	**109**	**113**	**-1.9**
D.1.1 primary crops	54	44	44	48	34	43	-4.3
D.1.1.1 Cereals, primary and processed	33	24	24	28	17	24	-6.1
D.1.1.2 Roots and tubers, primary and processed	0.6	0.6	0.6	0.6	0.6	0.6	-0.3
D.1.1.3 Sugar crops, primary and processed	6.2	6.7	5.1	5.3	4.3	6.1	-0.4
D.1.1.4 Pulses, primary and processed	0.1	0.1	0.1	0.1	0.0	0.0	-14.6
D.1.1.5 Nuts, primary and processed	0.1	0.1	0.1	0.1	0.1	0.1	7.3
D.1.1.6 Oil bearing crops, primary and processed	1.7	1.3	1.7	1.0	0.6	0.8	-14.8
D.1.1.7 Vegetables, primary and processed	3.3	4.4	5.8	5.4	4.6	4.6	6.5
D.1.1.8 Fruits, primary and processed	3.0	3.1	3.2	3.0	3.2	3.2	1.6
D.1.1.9 Fibres, primary and processed	0.2	0.2	0.2	0.2	0.3	0.3	5.5

Year	2000	2001	2002	2003	2004	2005	Average increase in %/a for the period 2000 to 2005
D.1.1.10 Other crops (Spices Stimulant crops, Tobacco, Rubber and other crops), primary and processed	1.1	1.2	1.1	1.2	1.6	1.3	4.1
D.1.2 Crop residues	2.3	1.9	2.2	2.2	2.4	2.5	2.1
D.1.2.1 n.a.							
D.1.2.2 Other crop residues (sugar and fodder beet leaves, other)	2.2	1.6	1.9	1.9	2.2	2.4	1.8
D.1.3 Fodder crops incl grassland harvest	0.6	0.6	0.7	0.8	0.7	0.7	1.4
D.1.3.1 Fodder crops	0.6	0.6	0.7	0.8	0.7	0.7	1.7
D.1.3.2 Biomass harvested from grassland							
D.1.4 n.a.							
D.1.5 Wood primary and processed	29	29	32	34	26	22	-5.1
D.1.5.1 Timber, primary and processed	22	22	24	25	18	14	-8.4
D.1.5.2 Wood fuel and other extraction, primary and processed	6.4	6.8	8.0	8.7	8.5	8.0	4.6
D.1.6 Fish capture, crustaceans, molluscs and aquatic invertebrates primary and processed	1.3	1.5	1.4	1.5	1.5	1.3	1.0
D.1.7 n.a.							
D.1.8 Live animals other than in B 1.6., meat and meat products	7.5	6.8	7.3	7.3	7.6	7.2	-0.8
D.1.8.1 Live animals other than in B 1.6.	0.3	0.2	0.3	0.3	0.3	0.2	-9.0
D.1.8.2 Meat and meat preparations	3.8	3.4	3.5	3.4	3.6	3.4	-2.2
D.1.8.3 Dairy products, birds eggs, and honey	2.3	2.0	2.0	2.2	2.2	2.1	-1.7
D.1.8.4 Other products from animals (animal fibres, skins, furs, leather etc.)	1.4	1.4	1.7	1.7	1.8	1.7	4.0
D.1.9 Products mainly from biomass	28	29	33	34	34	34	4.0
D.2 Metal ores and concentrates, processed metals	**85**	**85**	**92**	**98**	**102**	**104**	**4.1**
D.2.1 Iron ores and concentrates, iron and steel	41	43	49	52	52	51	4.3
D.2.2 non-ferrous metal ores and concentrates, processed metals	7.1	6.3	6.0	6.4	6.7	7.3	0.5
D.2.2.1 Copper	1.2	1.1	1.1	0.9	1.0	1.1	-1.9
D.2.2.2 Nickel	0.1	0.1	0.1	0.1	0.1	0.2	13.7
D.2.2.3 Lead	0.2	0.1	0.2	0.3	0.2	0.2	-4.1
D.2.2.4 Zinc	0.4	0.4	0.3	0.4	0.4	0.5	4.7
D.2.2.5 Tin	0.0	0.0	0.0	0.0	0.0	0.0	-7.2
D.2.2.6 Gold, silver, platinum and other precious metals	0.0	0.0	0.0	0.0	0.0	0.0	5.1
D.2.2.7 Aluminium	3.6	3.1	2.9	3.3	3.5	3.9	1.6
D.2.2.8 Uranium and thorium	0.0	0.0	0.0	0.0	0.0	0.0	4.6
D.2.2.9 Other metals	1.6	1.3	1.4	1.4	1.5	1.5	-1.0
D.2.3 Products mainly from metals	25	35	38	39	44	46	12.8
D.3 Non metalic minerals primary and processed	**76**	**78**	**76**	**77**	**75**	**79**	**0.7**
D.3.1 Ornamental or building stone	5.1	5.1	5.3	5.4	5.3	5.5	1.4
D.3.2 Limestone, gypsum, chalk, and dolomite	16	15	15	15	15	15	-1.5
D.3.3 Slate	0.1	0.0	0.1	0.1	0.1	0.1	0.7
D.3.4 Gravel and sand	18	20	19	16	17	16	-2.0
D.3.5 Clays and kaolin	6.9	7.1	7.4	7.6	7.6	7.7	2.0

Year	2000	2001	2002	2003	2004	2005	Average increase in %/a for the period 2000 to 2005
D.3.6 Chemical and fertilizer minerals	22	21	21	23	22	25	2.1
D.3.7 Salt	2.3	2.2	2.6	2.9	3.4	3.3	7.5
D.3.8 Other mining and quarrying products n.e.c.	17	17	17	18	19	19	2.6
D.3.9 Excavated soil, only if used (e.g for construction work)							
D.3.10 Products mainly from non-metalic minerals	21	20	18	19	18	19	-1.2
D.4 Fossil energy carriers, primary and processed	**153**	**151**	**154**	**155**	**170**	**185**	**3.9**
D.4.1 Brown coal incl. oil shale and tar sands	0.1	0.1	0.0	0.1	0.1	0.2	15.2
D.4.2 Hard coal	29	36	26	25	33	33	2.7
D.4.3 Petroleum	122	117	80	117	97	99	-4.1
D.4.4 Natural gas	2.5	2.9	4.8	5.5	6.3	7.8	25.8
D.4.5 Peat	1.2	1.3	1.5	1.7	1.0	0.6	-12.2
D.4.6 Products mainly from fossil energy carriers	24	26	27	30	29	30	4.3
D.5 Other products	**27**	**28**	**29**	**30**	**29**	**30**	**2.4**

Annex 5: Future waste generation numeric data

MUNICIPAL SOLID WASTE

Table 78: MSW generation assessment for the different groups of Member States

YELLOW	avg/inh	total
2006	394	35.457.980
2007	426	38.314.013
2008	426	38.258.918
2009	426	38.155.373
2010	453	40.456.302
2011	481	42.894.823
2012	501	44.603.666
2013	521	46.382.011
2014	543	48.230.827
2015	554	49.159.146
2016	565	50.100.598
2017	568	50.219.338
2018	568	50.135.021
2019	568	50.042.263
2020	568	49.941.320
2021	568	49.831.206
2022	568	49.708.955
2023	568	49.574.533
2024	568	49.428.790
2025	568	49.270.706
2026	568	49.101.771
2027	568	48.921.134
2028	568	48.730.290
2029	568	48.531.785
2030	568	48.325.976

turquoise	avg/inh	total
2006	421	14.785.941
2007	438	15.429.001
2008	438	15.502.272
2009	438	15.559.399
2010	455	16.237.814
2011	473	16.942.054
2012	492	17.674.669
2013	511	18.434.376
2014	513	18.545.751
2015	514	18.652.257
2016	516	18.755.597
2017	517	18.854.258
2018	519	18.948.528
2019	520	19.038.402
2020	522	19.124.451
2021	523	19.206.910
2022	525	19.285.296
2023	527	19.359.925
2024	528	19.430.854
2025	530	19.498.582
2026	531	19.564.745
2027	533	19.627.765
2028	535	19.688.927
2029	536	19.748.987
2030	538	19.808.211

lavender	avg/inh	total
2006	565	207.983.264
2007	565	209.169.923
2008	565	210.470.436
2009	565	210.419.918
2010	565	211.512.320
2011	565	212.542.910
2012	565	213.530.607
2013	565	214.473.296
2014	565	215.372.171
2015	565	216.227.012
2016	565	217.037.975
2017	565	217.807.719
2018	565	218.541.592
2019	565	219.237.200
2020	565	219.899.045
2021	565	220.527.383
2022	565	221.123.237
2023	565	221.686.261
2024	565	222.216.424
2025	565	222.720.234
2026	565	223.195.351
2027	565	223.644.769
2028	565	224.067.832
2029	565	224.468.971
2030	565	224.848.636

Table 79: MSW generation assessment for the EU

EU	total (tonnes)	kg/inh
2006	258.227.185	523,55
2007	262.912.937	530,81
2008	264.231.626	530,96
2009	264.134.690	530,98
2010	268.206.436	537,07
2011	272.379.787	543,44
2012	275.808.942	548,36
2013	279.289.683	553,43
2014	282.148.749	557,35
2015	284.038.415	559,43
2016	285.894.170	561,54
2017	286.881.315	562,03
2018	287.625.141	562,14
2019	288.317.865	562,25
2020	288.964.816	562,37
2021	289.565.499	562,48
2022	290.117.488	562,59
2023	290.620.719	562,70
2024	291.076.068	562,81
2025	291.489.522	562,93
2026	291.861.867	563,04
2027	292.193.668	563,15
2028	292.487.049	563,27
2029	292.749.743	563,38
2030	292.982.823	563,49

Table 80: Generation per fraction of MSW for the yellow group of Member States, in kg/inh

	bio waste	paper and (	plastics	glass	metals	other	TOTAL
2005	120,12	36,40	32,76	29,12	7,28	138,32	**364,00**
2006	126,53	46,45	32,94	29,86	7,90	144,86	**388,52**
2007	133,27	52,86	33,11	30,61	8,57	151,70	**410,12**
2008	133,27	52,86	33,11	30,61	8,57	151,70	**410,12**
2009	133,27	52,86	33,11	30,61	8,57	151,70	**410,12**
2010	140,38	60,15	33,24	31,19	9,12	157,08	**431,16**
2011	147,87	68,45	33,38	31,78	9,70	162,64	**453,81**
2012	155,75	77,90	33,47	32,18	10,11	166,48	**475,89**
2013	164,06	88,65	33,56	32,59	10,54	170,42	**499,80**
2014	172,81	100,88	33,65	33,00	10,99	174,44	**525,76**
2015	182,03	101,70	33,69	33,21	11,22	176,50	**538,35**
2016	191,73	101,70	33,74	33,42	11,30	178,59	**550,48**
2017	201,96	101,70	33,78	33,63	11,30	180,70	**563,07**
2018	202,57	101,70	33,78	33,63	11,30	180,70	**563,67**
2019	203,17	101,70	33,78	33,63	11,30	180,70	**564,28**
2020	203,40	101,70	33,78	33,63	11,30	180,70	**564,51**
2021	203,40	101,70	33,78	33,63	11,30	180,70	**564,51**
2022	203,40	101,70	33,78	33,63	11,30	180,70	**564,51**
2023	203,40	101,70	33,78	33,63	11,30	180,70	**564,51**
2024	203,40	101,70	33,78	33,63	11,30	180,70	**564,51**
2025	203,40	101,70	33,78	33,63	11,30	180,70	**564,51**
2026	203,40	101,70	33,78	33,63	11,30	180,70	**564,51**
2027	203,40	101,70	33,78	33,63	11,30	180,70	**564,51**
2028	203,40	101,70	33,78	33,63	11,30	180,70	**564,51**
2029	203,40	101,70	33,78	33,63	11,30	180,70	**564,51**
2030	203,40	101,70	33,78	33,63	11,30	180,70	**564,51**

Table 81: Generation per fraction of MSW for the yellow group of Member States, in tonnes

	bio waste	paper and card	plastics	glass	metals	other	TOTAL
2005	10.829.425	3.281.644	2.953.479	2.625.315	656.329	12.470.247	**32.816.439**
2006	11.386.637	4.179.891	2.963.998	2.686.816	710.817	13.036.164	**34.964.323**
2007	11.973.102	4.748.453	2.974.699	2.749.890	769.866	13.628.426	**36.844.436**
2008	11.955.885	4.741.625	2.970.421	2.745.936	768.759	13.608.829	**36.791.455**
2009	11.923.527	4.728.792	2.962.382	2.738.504	766.678	13.571.998	**36.691.881**
2010	12.541.519	5.373.677	2.970.036	2.786.394	814.365	14.032.903	**38.518.894**
2011	13.191.182	6.106.342	2.977.629	2.835.044	864.993	14.509.067	**40.484.257**
2012	13.876.349	6.939.826	2.981.660	2.867.053	900.545	14.832.232	**42.397.665**
2013	14.597.552	7.887.319	2.985.788	2.899.513	937.588	15.163.061	**44.470.821**
2014	15.356.102	8.964.093	2.989.895	2.932.313	976.145	15.501.130	**46.719.678**
2015	16.153.531	9.025.125	2.989.911	2.946.898	995.549	15.663.353	**47.774.367**
2016	16.990.764	9.012.260	2.989.645	2.961.276	1.001.362	15.825.777	**48.781.084**
2017	17.869.149	8.998.284	2.989.004	2.975.350	999.809	15.987.880	**49.819.476**
2018	17.892.665	8.983.176	2.983.985	2.970.355	998.131	15.961.037	**49.789.349**
2019	17.913.139	8.966.555	2.978.464	2.964.859	996.284	15.931.506	**49.750.807**
2020	17.896.937	8.948.468	2.972.456	2.958.878	994.274	15.899.370	**49.670.383**
2021	17.857.477	8.928.738	2.965.902	2.952.355	992.082	15.864.314	**49.560.868**
2022	17.813.667	8.906.833	2.958.626	2.945.112	989.648	15.825.394	**49.439.280**
2023	17.765.495	8.882.748	2.950.625	2.937.147	986.972	15.782.599	**49.305.586**
2024	17.713.267	8.856.633	2.941.951	2.928.513	984.070	15.736.200	**49.160.634**
2025	17.656.616	8.828.308	2.932.542	2.919.147	980.923	15.685.873	**49.003.409**
2026	17.596.077	8.798.038	2.922.487	2.909.138	977.560	15.632.090	**48.835.390**
2027	17.531.344	8.765.672	2.911.736	2.898.435	973.964	15.574.583	**48.655.734**
2028	17.462.953	8.731.477	2.900.377	2.887.128	970.164	15.513.825	**48.465.924**
2029	17.391.817	8.695.908	2.888.562	2.875.368	966.212	15.450.629	**48.268.496**
2030	17.318.063	8.659.032	2.876.313	2.863.174	962.115	15.385.108	**48.063.805**

Table 82: Generation per fraction of MSW for the turquoise group of Member States, in kg/inh

	bio waste	paper and (	plastics	glass	metals	other	TOTAL
2005	145,80	68,85	28,35	16,20	16,20	129,60	**405,00**
2006	151,04	71,84	28,85	17,81	11,30	134,25	**415,09**
2007	156,46	74,95	29,37	19,58	10,99	139,08	**430,42**
2008	156,46	74,95	29,37	19,58	10,99	139,08	**430,42**
2009	156,46	74,95	29,37	19,58	10,99	139,08	**430,42**
2010	162,08	78,20	29,89	21,52	10,69	144,07	**446,45**
2011	167,90	81,60	30,42	23,66	10,39	149,25	**463,22**
2012	173,93	85,13	30,96	26,01	10,11	154,61	**480,75**
2013	180,18	88,83	31,52	28,59	9,83	160,16	**499,10**
2014	180,72	89,09	31,61	28,68	9,86	160,64	**500,60**
2015	181,26	89,36	31,70	28,77	9,89	161,12	**502,10**
2016	181,80	89,63	31,80	28,85	9,92	161,60	**503,61**
2017	182,35	89,90	31,90	28,94	9,95	162,09	**505,12**
2018	182,90	90,17	31,99	29,03	9,98	162,57	**506,63**
2019	183,45	90,44	32,09	29,11	10,01	163,06	**508,15**
2020	184,00	90,71	32,18	29,20	10,04	163,55	**509,68**
2021	184,55	90,98	32,28	29,29	10,07	164,04	**511,21**
2022	185,10	91,25	32,38	29,38	10,10	164,53	**512,74**
2023	185,66	91,53	32,47	29,46	10,13	165,03	**514,28**
2024	186,21	91,80	32,57	29,55	10,16	165,52	**515,82**
2025	186,77	92,08	32,67	29,64	10,19	166,02	**517,37**
2026	187,33	92,35	32,77	29,73	10,22	166,52	**518,92**
2027	187,89	92,63	32,86	29,82	10,25	167,02	**520,48**
2028	188,46	92,91	32,96	29,91	10,28	167,52	**522,04**
2029	189,02	93,19	33,06	30,00	10,31	168,02	**523,61**
2030	189,59	93,47	33,16	30,09	10,34	168,53	**525,18**

Table 83: Generation per fraction of MSW for the turquoise group of Member States, in tonnes

	bio waste	paper and card	plastics	glass	metals	other	TOTAL
2005	5.100.378	2.408.512	991.740	566.709	566.709	4.533.669	**14.167.716**
2006	5.304.492	2.522.938	1.013.390	625.466	396.863	4.715.104	**14.578.253**
2007	5.516.009	2.588.361	1.014.181	676.096	379.498	4.802.785	**14.976.930**
2008	5.542.204	2.593.250	1.016.097	677.373	380.215	4.811.856	**15.020.995**
2009	5.562.627	2.602.686	1.019.794	679.838	381.598	4.829.364	**15.075.907**
2010	5.785.049	2.725.656	1.041.795	750.138	372.483	5.021.377	**15.696.498**
2011	6.015.030	2.854.371	1.064.247	827.688	363.577	5.220.905	**16.345.818**
2012	6.253.388	2.989.979	1.087.480	913.505	354.980	5.429.843	**17.029.175**
2013	6.499.573	3.131.596	1.111.065	1.008.080	346.539	5.646.358	**17.743.211**
2014	6.538.842	3.155.907	1.119.691	1.015.906	349.229	5.690.192	**17.869.767**
2015	6.576.394	3.177.040	1.127.188	1.022.708	351.568	5.728.294	**17.983.192**
2016	6.612.829	3.199.091	1.135.012	1.029.807	354.008	5.768.053	**18.098.800**
2017	6.647.615	3.220.582	1.142.637	1.036.725	356.386	5.806.802	**18.210.747**
2018	6.680.853	3.241.820	1.150.172	1.043.561	358.736	5.845.094	**18.320.236**
2019	6.712.540	3.262.385	1.157.468	1.050.182	361.012	5.882.175	**18.425.762**
2020	6.742.879	3.282.096	1.164.461	1.056.526	363.193	5.917.713	**18.526.868**
2021	6.771.953	3.300.944	1.171.149	1.062.594	365.279	5.951.698	**18.623.617**
2022	6.799.590	3.319.233	1.177.637	1.068.481	367.303	5.984.672	**18.716.916**
2023	6.825.902	3.336.693	1.183.832	1.074.102	369.235	6.016.154	**18.805.918**
2024	6.850.911	3.353.376	1.189.751	1.079.472	371.081	6.046.234	**18.890.825**
2025	6.874.790	3.369.282	1.195.394	1.084.592	372.841	6.074.912	**18.971.811**
2026	6.898.118	3.384.510	1.200.797	1.089.494	374.526	6.102.369	**19.049.814**
2027	6.920.337	3.399.103	1.205.974	1.094.192	376.141	6.128.681	**19.124.428**
2028	6.941.902	3.412.975	1.210.896	1.098.657	377.676	6.153.693	**19.195.799**
2029	6.963.078	3.426.182	1.215.582	1.102.909	379.138	6.177.506	**19.264.395**
2030	6.983.959	3.438.735	1.220.036	1.106.950	380.527	6.200.138	**19.330.345**

Table 84: Generation per fraction of MSW for the lavender group of Member States, in kg/inh

	bio waste	paper and c	plastics	glass	metals	other	TOTAL
2005	203,40	101,70	33,90	33,90	11,30	180,80	**565,00**
2006	203,40	101,70	33,90	33,90	11,30	180,80	**565,00**
2029	203,40	101,70	33,90	33,90	11,30	180,80	**565,00**
2030	203,40	101,70	33,90	33,90	11,30	180,80	**565,00**

Table 85: Generation per fraction of MSW for the lavender group of Member States, in tonnes

	bio waste	paper and card	plastics	glass	metals	other	TOTAL
2005	74.447.772	37.223.886	12.407.962	12.407.962	4.135.987	66.175.797	**206.799.366**
2006	74.873.975	37.436.987	12.478.996	12.478.996	4.159.665	66.554.644	**207.983.263**
2007	75.301.172	37.650.586	12.550.195	12.550.195	4.183.398	66.934.375	**209.169.921**
2008	75.769.357	37.884.678	12.628.226	12.628.226	4.209.409	67.350.540	**210.470.436**
2009	75.751.170	37.875.585	12.625.195	12.625.195	4.208.398	67.334.374	**210.419.917**
2010	76.144.435	38.072.218	12.690.739	12.690.739	4.230.246	67.683.942	**211.512.319**
2011	76.515.447	38.257.724	12.752.575	12.752.575	4.250.858	68.013.731	**212.542.910**
2012	76.871.019	38.435.509	12.811.836	12.811.836	4.270.612	68.329.794	**213.530.606**
2013	77.210.387	38.605.193	12.868.398	12.868.398	4.289.466	68.631.455	**214.473.297**
2014	77.533.982	38.766.991	12.922.330	12.922.330	4.307.443	68.919.095	**215.372.171**
2015	77.841.724	38.920.862	12.973.621	12.973.621	4.324.540	69.192.644	**216.227.012**
2016	78.133.671	39.066.835	13.022.278	13.022.278	4.340.759	69.452.152	**217.037.973**
2017	78.410.779	39.205.389	13.068.463	13.068.463	4.356.154	69.698.470	**217.807.718**
2018	78.674.973	39.337.486	13.112.495	13.112.495	4.370.832	69.933.309	**218.541.590**
2019	78.925.392	39.462.696	13.154.232	13.154.232	4.384.744	70.155.904	**219.237.200**
2020	79.163.656	39.581.828	13.193.943	13.193.943	4.397.981	70.367.694	**219.899.045**
2021	79.389.858	39.694.929	13.231.643	13.231.643	4.410.548	70.568.763	**220.527.384**
2022	79.604.365	39.802.183	13.267.394	13.267.394	4.422.465	70.759.436	**221.123.237**
2023	79.807.054	39.903.527	13.301.176	13.301.176	4.433.725	70.939.604	**221.686.262**
2024	79.997.913	39.998.956	13.332.985	13.332.985	4.444.328	71.109.256	**222.216.423**
2025	80.179.284	40.089.642	13.363.214	13.363.214	4.454.405	71.270.475	**222.720.234**
2026	80.350.326	40.175.163	13.391.721	13.391.721	4.463.907	71.422.512	**223.195.350**
2027	80.512.117	40.256.058	13.418.686	13.418.686	4.472.895	71.566.326	**223.644.768**
2028	80.664.420	40.332.210	13.444.070	13.444.070	4.481.357	71.701.706	**224.067.833**
2029	80.808.830	40.404.415	13.468.138	13.468.138	4.489.379	71.830.071	**224.468.971**
2030	80.945.509	40.472.754	13.490.918	13.490.918	4.496.973	71.951.563	**224.848.635**

Table 86: Generation per fraction of MSW for the EU, in tonnes

	bio waste	paper and carc	plastics	glass	metals	other	TOTAL
2005	90.377.574	42.914.042	16.353.182	15.599.986	5.359.025	83.179.713	253.783.521
2006	91.565.104	44.139.816	16.456.384	15.791.278	5.267.345	84.305.912	257.525.839
2007	92.790.283	44.987.400	16.539.075	15.976.181	5.332.762	85.365.586	260.991.287
2008	93.267.446	45.219.553	16.614.744	16.051.535	5.358.383	85.771.225	262.282.886
2009	93.237.324	45.207.063	16.607.371	16.043.537	5.356.674	85.735.736	262.187.705
2010	94.471.003	46.171.551	16.702.570	16.227.271	5.417.094	86.738.222	265.727.711
2011	95.721.659	47.218.437	16.794.451	16.415.307	5.479.428	87.743.703	269.372.985
2012	97.000.756	48.365.314	16.880.976	16.592.394	5.526.137	88.591.869	272.957.446
2013	98.307.512	49.624.108	16.965.251	16.775.991	5.573.593	89.440.874	276.687.329
2014	99.428.926	50.886.991	17.031.916	16.870.549	5.632.817	90.110.417	279.961.616
2015	100.571.649	51.123.027	17.090.720	16.943.227	5.671.657	90.584.291	281.984.571
2016	101.737.264	51.278.186	17.146.935	17.013.361	5.696.129	91.045.982	283.917.857
2017	102.927.543	51.424.255	17.200.104	17.080.538	5.712.349	91.493.152	285.837.941
2018	103.248.491	51.562.482	17.246.652	17.126.411	5.727.699	91.739.440	286.651.175
2019	103.551.071	51.691.636	17.290.164	17.169.273	5.742.040	91.969.585	287.413.769
2020	103.803.472	51.812.392	17.330.860	17.209.347	5.755.448	92.184.777	288.096.296
2021	104.019.288	51.924.611	17.368.694	17.246.592	5.767.909	92.384.775	288.711.869
2022	104.217.622	52.028.249	17.403.657	17.280.987	5.779.416	92.569.502	289.279.433
2023	104.398.451	52.122.968	17.435.633	17.312.425	5.789.932	92.738.357	289.797.766
2024	104.562.091	52.208.965	17.464.687	17.340.970	5.799.479	92.891.690	290.267.882
2025	104.710.690	52.287.232	17.491.150	17.366.953	5.808.169	93.031.260	290.695.454
2026	104.844.521	52.357.711	17.515.005	17.390.353	5.815.993	93.156.971	291.080.554
2027	104.963.798	52.420.833	17.536.396	17.411.313	5.823.000	93.269.590	291.424.930
2028	105.069.275	52.476.662	17.555.343	17.429.855	5.829.197	93.369.224	291.729.556
2029	105.163.725	52.526.505	17.572.282	17.446.415	5.834.729	93.458.206	292.001.862
2030	105.247.531	52.570.521	17.587.267	17.461.042	5.839.615	93.536.809	292.242.785

Table 87: Assessed landfill tor the different groups of Member States in tonnes

yellow	landfilled	landfilled cum	turquoise	landfilled	landfilled cum	lavender	landfilled	landfilled cum
2005	23.167.483	23.167.483	2005	11.848.562	11.848.562	2005	77.160.823	77.160.823
2006	24.683.829	47.851.311	2006	12.191.897	24.040.459	2006	77.602.557	154.763.380
2007	25.409.765	73.261.076	2007	12.239.896	36.280.355	2007	74.998.712	229.762.092
2008	25.352.992	98.614.068	2008	12.191.791	48.472.146	2008	73.291.068	303.053.159
2009	24.943.141	123.557.209	2009	11.646.892	60.119.038	2009	72.328.690	375.381.849
2010	26.144.699	149.701.908	2010	11.802.197	71.921.235	2010	64.419.249	439.801.099
2011	26.051.619	175.753.528	2011	11.411.424	83.332.659	2011	56.509.846	496.310.945
2012	26.759.286	202.512.814	2012	11.556.424	94.889.083	2012	50.473.297	546.784.242
2013	27.222.813	229.735.627	2013	11.366.745	106.255.827	2013	44.369.163	591.153.405
2014	27.646.369	257.381.996	2014	11.099.359	117.355.186	2014	40.355.361	631.508.766
2015	26.772.755	284.154.752	2015	10.214.453	127.569.639	2015	36.299.110	667.807.876
2016	25.756.412	309.911.164	2016	9.927.192	137.496.831	2016	31.880.979	699.688.855
2017	23.651.796	333.562.960	2017	9.469.588	146.966.420	2017	27.508.570	727.197.425
2018	22.417.654	355.980.615	2018	9.258.589	156.225.009	2018	23.185.897	750.383.322
2019	22.151.547	378.132.161	2019	9.132.268	165.357.277	2019	20.967.846	771.351.168
2020	20.346.234	398.478.395	2020	8.482.942	173.840.219	2020	18.775.255	790.126.423
2021	20.292.697	418.771.093	2021	8.428.234	182.268.453	2021	18.828.904	808.955.327
2022	20.242.913	439.014.006	2022	8.388.220	190.656.673	2022	18.879.778	827.835.105
2023	20.188.172	459.202.178	2023	8.428.107	199.084.780	2023	18.927.850	846.762.955
2024	20.128.822	479.331.000	2024	8.466.159	207.550.940	2024	18.973.116	865.736.071
2025	20.064.446	499.395.445	2025	8.502.454	216.053.394	2025	19.016.132	884.752.203
2026	19.995.650	519.391.096	2026	8.537.412	224.590.806	2026	19.056.698	903.808.901
2027	19.922.090	539.313.186	2027	8.570.851	233.161.658	2027	19.095.070	922.903.971
2028	19.844.373	559.157.559	2028	8.602.837	241.764.495	2028	19.131.192	942.035.163
2029	19.763.536	578.921.094	2029	8.633.579	250.398.074	2029	19.165.441	961.200.604
2030	19.679.725	598.600.819	2030	8.663.136	259.061.210	2030	19.197.858	980.398.462

Table 88: Assessed landfill tor the EU in tonnes

EU	landfilled	landfilled cumu
2005	112.176.868	112.176.868
2006	114.478.283	226.655.150
2007	112.648.373	339.303.524
2008	110.835.850	450.139.373
2009	108.918.723	559.058.096
2010	102.366.146	661.424.242
2011	93.972.890	755.397.132
2012	88.789.007	844.186.139
2013	82.958.721	927.144.860
2014	79.101.089	1.006.245.949
2015	73.286.318	1.079.532.267
2016	67.564.583	1.147.096.850
2017	60.629.955	1.207.726.805
2018	54.862.140	1.262.588.945
2019	52.251.661	1.314.840.606
2020	47.604.431	1.362.445.037
2021	47.549.835	1.409.994.873
2022	47.510.911	1.457.505.784
2023	47.544.130	1.505.049.914
2024	47.568.097	1.552.618.011
2025	47.583.032	1.600.201.043
2026	47.589.761	1.647.790.803
2027	47.588.012	1.695.378.815
2028	47.578.402	1.742.957.216
2029	47.562.556	1.790.519.773
2030	47.540.718	1.838.060.491

Table 89: Assessed incineration in the different groups of Member States in tonnes

yellow	incinerated
2005	1.132.177
2006	1.206.280
2007	1.328.242
2008	1.346.567
2009	1.372.276
2010	1.461.792
2011	1.639.612
2012	2.185.600
2013	2.559.296
2014	2.978.379
2015	3.363.315
2016	3.804.925
2017	4.222.201
2018	4.493.489
2019	4.738.764
2020	4.764.857
2021	4.755.365
2022	4.743.699
2023	4.730.871
2024	4.716.963
2025	4.701.877
2026	4.685.756
2027	4.668.518
2028	4.650.305
2029	4.631.362
2030	4.611.722

turquoise	incinerated
2005	270.699
2006	278.543
2007	351.209
2008	429.225
2009	602.282
2010	791.496
2011	1.031.830
2012	1.083.481
2013	1.164.398
2014	1.181.638
2015	1.222.857
2016	1.239.768
2017	1.274.752
2018	1.289.287
2019	1.301.319
2020	1.250.036
2021	1.262.798
2022	1.275.792
2023	1.281.858
2024	1.287.646
2025	1.293.166
2026	1.298.483
2027	1.303.569
2028	1.308.434
2029	1.313.109
2030	1.317.605

lavender	incinerated
2005	52.761.088
2006	53.063.137
2007	53.497.299
2008	55.436.860
2009	55.528.764
2010	55.975.678
2011	56.509.846
2012	56.879.215
2013	57.237.561
2014	57.585.134
2015	57.921.811
2016	57.665.090
2017	57.391.789
2018	57.103.552
2019	56.747.357
2020	56.377.992
2021	56.539.086
2022	56.691.852
2023	56.836.201
2024	56.972.124
2025	57.101.292
2026	57.223.103
2027	57.338.325
2028	57.446.791
2029	57.549.635
2030	57.646.974

Table 90: Assessed incineration in the EU in tonnes

EU	incineration capac
2005	54.163.964
2006	54.547.961
2007	55.176.750
2008	57.212.653
2009	57.503.323
2010	58.228.966
2011	59.181.288
2012	60.148.296
2013	60.961.255
2014	61.745.152
2015	62.507.983
2016	62.709.783
2017	62.888.742
2018	62.886.327
2019	62.787.441
2020	62.392.885
2021	62.557.249
2022	62.711.343
2023	62.848.930
2024	62.976.733
2025	63.096.335
2026	63.207.341
2027	63.310.412
2028	63.405.530
2029	63.494.107
2030	63.576.301

Table 91: Assessed recycling in yellow group of Member States in tonnes

yellow	paper cardboard	plastic	glass	metals	other
2005	904.700	176.424	334.499	192.655	1.542.648
2006	963.914	187.971	356.393	205.264	1.643.616
2007	1.267.449	316.862	316.862	316.862	1.901.173
2008	1.280.343	320.086	320.086	320.086	1.920.514
2009	1.614.443	322.889	322.889	322.889	1.937.331
2010	1.714.091	342.818	342.818	342.818	2.056.909
2011	2.186.150	728.717	728.717	364.358	2.186.150
2012	2.340.351	780.117	780.117	390.059	2.730.410
2013	2.926.180	836.051	836.051	418.026	2.926.180
2014	3.139.562	897.018	897.018	448.509	3.139.562
2015	3.745.510	936.378	936.378	468.189	3.277.322
2016	3.902.487	1.463.433	975.622	487.811	3.414.676
2017	4.483.753	1.494.584	996.390	498.195	3.985.558
2018	4.481.041	1.493.680	995.787	497.893	3.983.148
2019	4.477.573	1.492.524	995.016	497.508	3.980.065
2020	4.250.522	1.411.917	1.405.467	472.280	3.774.949
2021	4.237.454	1.412.485	1.412.485	470.828	3.766.626
2022	4.227.058	1.409.019	1.409.019	469.673	3.757.385
2023	4.215.628	1.405.209	1.405.209	468.403	3.747.225
2024	4.203.234	1.401.078	1.401.078	467.026	3.736.208
2025	4.189.791	1.396.597	1.396.597	465.532	3.724.259
2026	4.175.426	1.391.809	1.391.809	463.936	3.711.490
2027	4.160.065	1.386.688	1.386.688	462.229	3.697.836
2028	4.143.837	1.381.279	1.381.279	460.426	3.683.410
2029	4.126.956	1.375.652	1.375.652	458.551	3.668.406
2030	4.109.455	1.369.818	1.369.818	456.606	3.652.849

Table 92: Assessed recycling in turquoise group of Member States in tonnes

turquoise	paper cardboard	plastic	glass	metals	other
2005	816.415	112.253	275.476	155.941	491.487
2006	840.072	115.506	283.458	160.460	505.729
2007	880.643	146.774	293.548	146.774	587.096
2008	887.741	147.957	295.914	147.957	591.827
2009	895.509	149.251	298.503	149.251	746.257
2010	937.081	156.180	312.360	156.180	780.901
2011	980.749	326.916	326.916	163.458	980.749
2012	1.192.042	340.584	340.584	170.292	1.021.751
2013	1.242.025	354.864	532.296	177.432	1.242.025
2014	1.250.884	357.395	536.093	178.698	1.250.884
2015	1.438.655	539.496	539.496	179.832	1.258.823
2016	1.447.904	542.964	542.964	180.988	1.266.916
2017	1.456.860	546.322	546.322	182.107	1.456.860
2018	1.557.220	549.607	549.607	183.202	1.465.619
2019	1.566.190	552.773	552.773	184.258	1.474.061
2020	1.566.219	555.682	504.175	173.316	1.408.042
2021	1.592.319	530.773	619.235	176.924	1.415.395
2022	1.600.296	533.432	711.243	177.811	1.422.486
2023	1.607.906	535.969	714.625	178.656	1.429.250
2024	1.615.166	538.389	717.851	179.463	1.435.703
2025	1.622.090	540.697	720.929	180.232	1.441.858
2026	1.628.759	542.920	723.893	180.973	1.447.786
2027	1.635.139	545.046	726.728	181.682	1.453.457
2028	1.641.241	547.080	729.440	182.360	1.458.881
2029	1.647.106	549.035	732.047	183.012	1.464.094
2030	1.652.744	550.915	734.553	183.638	1.469.106

Table 93: Assessed recycling in lavender group of Member States in tonnes

lavender	paper cardboard	plastic	glass	metals	other
2005	24.262.149	6.643.940	10.825.821	2.885.679	20.337.336
2006	24.401.047	6.681.976	10.887.797	2.902.199	20.453.765
2007	25.050.190	7.306.305	11.481.337	2.505.019	20.875.158
2008	25.205.939	7.351.732	11.552.722	3.150.742	21.004.950
2009	25.199.889	8.399.963	11.549.949	3.149.986	20.999.908
2010	27.441.608	8.443.572	11.609.911	3.166.339	21.108.929
2011	29.756.007	8.501.716	11.689.860	3.188.144	21.254.291
2012	29.894.285	8.541.224	11.744.183	3.202.959	21.353.061
2013	30.026.262	8.578.932	11.796.031	3.217.099	21.447.330
2014	30.152.104	8.614.887	11.845.469	3.230.583	21.537.217
2015	30.271.782	8.649.080	11.892.486	3.243.405	21.622.701
2016	30.081.463	8.594.704	11.817.718	3.223.014	21.486.759
2017	29.883.219	8.538.063	11.739.836	3.201.773	21.345.156
2018	29.677.948	8.479.414	11.659.194	3.179.780	21.198.534
2019	29.465.480	8.418.708	11.575.724	3.157.016	21.046.771
2020	29.246.573	8.356.164	11.489.725	3.133.561	20.890.409
2021	29.330.142	8.380.041	11.522.556	3.142.515	20.950.101
2022	29.409.391	8.402.683	11.553.689	3.151.006	21.006.708
2023	29.484.273	8.424.078	11.583.107	3.159.029	21.060.195
2024	29.554.784	8.444.224	11.610.808	3.166.584	21.110.560
2025	29.621.791	8.463.369	11.637.132	3.173.763	21.158.422
2026	29.684.982	8.481.423	11.661.957	3.180.534	21.203.558
2027	29.744.754	8.498.501	11.685.439	3.186.938	21.246.253
2028	29.801.022	8.514.578	11.707.544	3.192.967	21.286.444
2029	29.854.373	8.529.821	11.728.504	3.198.683	21.324.552
2030	29.904.868	8.544.248	11.748.341	3.204.093	21.360.620

Table 94: Assessed recycling in EU in tonnes

EU	paper cardboard	plastic	glass	metals	other
2005	25.983.264	6.932.617	11.435.796	3.234.274	22.371.472
2006	26.205.033	6.985.453	11.527.648	3.267.923	22.603.110
2007	27.198.282	7.769.941	12.091.747	2.968.655	23.363.427
2008	27.374.023	7.819.775	12.168.721	3.618.785	23.517.291
2009	27.709.841	8.872.103	12.171.341	3.622.126	23.683.496
2010	30.092.780	8.942.570	12.265.090	3.665.338	23.946.739
2011	32.922.906	9.557.349	12.745.493	3.715.960	24.421.190
2012	33.426.678	9.661.925	12.864.884	3.763.309	25.105.221
2013	34.194.466	9.769.848	13.164.379	3.812.557	25.615.534
2014	34.542.550	9.869.300	13.278.580	3.857.789	25.927.663
2015	35.455.947	10.124.954	13.368.359	3.891.426	26.158.846
2016	35.431.854	10.601.100	13.336.303	3.891.813	26.168.351
2017	35.823.832	10.578.969	13.282.548	3.882.076	26.787.574
2018	35.716.209	10.522.701	13.204.588	3.860.876	26.647.301
2019	35.509.242	10.464.006	13.123.513	3.838.781	26.500.897
2020	35.063.315	10.323.762	13.399.368	3.779.158	26.073.400
2021	35.159.916	10.323.298	13.554.276	3.790.268	26.132.122
2022	35.236.745	10.345.135	13.673.951	3.798.490	26.186.578
2023	35.307.806	10.365.256	13.702.941	3.806.089	26.236.669
2024	35.373.184	10.383.691	13.729.738	3.813.073	26.282.471
2025	35.433.672	10.400.663	13.754.658	3.819.528	26.324.539
2026	35.489.166	10.416.152	13.777.659	3.825.443	26.362.834
2027	35.539.958	10.430.236	13.798.856	3.830.849	26.397.545
2028	35.586.099	10.442.937	13.818.263	3.835.753	26.428.735
2029	35.628.435	10.454.508	13.836.203	3.840.245	26.457.052
2030	35.667.068	10.464.981	13.852.713	3.844.337	26.482.576

Table 95: Assessed composting and AD in different groups of Member States in tonnes

yellow	composting	backyard composting	AD	turquoise	composting	backyard composting	AD	lavender	composting	backyard composting	AD
2005	963.273	204.651	0	2005	57.644	0	12.742	2005	18.595.791	691.549	1.781.373
2006	1.026.320	218.046	0	2006	59.314	0	13.111	2006	18.702.250	695.508	1.791.571
2007	1.267.449	316.862	0	2007	73.387	146.774	73.387	2007	18.787.642	2.087.516	2.087.516
2008	1.600.428	320.086	0	2008	147.957	147.957	73.978	2008	18.904.455	2.100.495	2.100.495
2009	1.937.331	322.889	0	2009	298.503	298.503	149.251	2009	18.899.917	2.099.991	2.099.991
2010	2.399.727	342.818	0	2010	468.540	312.360	234.270	2010	21.108.929	4.221.786	4.221.786
2011	2.914.867	728.717	0	2011	817.291	490.375	245.187	2011	23.379.720	6.376.287	6.376.287
2012	3.510.527	780.117	0	2012	1.021.751	510.875	255.438	2012	25.623.673	8.541.224	8.541.224
2013	4.180.257	1.254.077	0	2013	1.242.025	709.728	266.148	2013	27.881.529	10.723.665	10.723.665
2014	5.382.107	1.794.036	0	2014	1.608.279	714.791	268.047	2014	30.152.104	10.768.609	12.922.330
2015	6.554.643	2.340.944	0	2015	1.978.151	899.160	359.664	2015	32.434.052	10.811.351	15.135.891
2016	7.804.973	2.926.865	0	2016	2.352.844	904.940	361.976	2016	34.378.815	10.743.380	17.189.407
2017	8.967.506	3.487.363	0	2017	2.731.612	910.537	364.215	2017	36.286.766	10.672.578	19.210.641
2018	9.957.870	3.485.254	0	2018	2.931.238	916.012	366.405	2018	38.157.362	10.599.267	21.198.534
2019	9.950.161	3.482.556	0	2019	3.132.380	921.288	368.515	2019	39.988.865	10.523.386	21.046.771
2020	9.437.373	3.303.080	0	2020	3.168.094	880.026	352.010	2020	41.780.819	10.445.205	20.890.409
2021	9.416.565	3.295.798	0	2021	3.184.639	884.622	353.849	2021	41.900.203	10.475.051	20.950.101
2022	9.393.463	3.287.712	0	2022	3.200.593	889.054	355.621	2022	42.013.415	10.503.354	21.006.708
2023	9.368.061	3.278.821	0	2023	3.215.812	893.281	357.312	2023	42.120.390	10.530.097	21.060.195
2024	9.340.520	3.269.182	0	2024	3.230.331	897.314	358.926	2024	42.221.120	10.555.280	21.110.560
2025	9.310.648	3.258.727	0	2025	3.244.180	901.161	360.464	2025	42.316.844	10.579.211	21.158.422
2026	9.278.724	3.247.553	0	2026	3.257.518	904.866	361.946	2026	42.407.117	10.601.779	21.203.558
2027	9.244.589	3.235.606	0	2027	3.270.277	908.410	363.364	2027	42.492.506	10.623.126	21.246.253
2028	9.208.526	3.222.984	0	2028	3.282.482	911.800	364.720	2028	42.572.888	10.643.222	21.286.444
2029	9.171.014	3.209.855	0	2029	3.294.212	915.059	366.024	2029	42.649.104	10.662.276	21.324.552
2030	9.132.123	3.196.243	0	2030	3.305.489	918.191	367.277	2030	42.721.241	10.680.310	21.360.620

Table 96: Assessed composting and AD in EU in tonnes

EU	composting	backyard comp	AD
2005	19.616.708	896.200	1.794.115
2006	19.787.884	913.554	1.804.682
2007	20.128.478	2.551.152	2.160.903
2008	20.652.840	2.568.537	2.174.473
2009	21.135.751	2.721.382	2.249.242
2010	23.977.197	4.876.964	4.456.056
2011	27.111.878	7.595.378	6.621.475
2012	30.155.950	9.832.217	8.796.662
2013	33.303.811	12.687.470	10.989.813
2014	37.142.490	13.277.435	13.190.377
2015	40.966.846	14.051.454	15.495.555
2016	44.536.632	14.575.185	17.551.383
2017	47.985.884	15.070.479	19.574.856
2018	51.046.469	15.000.533	21.564.939
2019	53.071.406	14.927.230	21.415.286
2020	54.386.286	14.628.311	21.242.420
2021	54.501.406	14.655.470	21.303.950
2022	54.607.471	14.680.119	21.362.329
2023	54.704.263	14.702.200	21.417.507
2024	54.791.972	14.721.776	21.469.486
2025	54.871.672	14.739.099	21.518.887
2026	54.943.359	14.754.199	21.565.505
2027	55.007.373	14.767.143	21.609.617
2028	55.063.895	14.778.006	21.651.164
2029	55.114.330	14.787.190	21.690.576
2030	55.158.853	14.794.745	21.727.897

INDUSTRIAL AND NON HOUSEHOLD WASTE

Table 97: Total generation of industrial and non household waste for different groups of Member States, in tonnes

yellow	tonnes	turquoise	tonnes	lavender	tonnes
2006	963.335	2006	104.543	2006	1.738.655
2007	1.042.737	2007	108.674	2007	1.790.059
2008	1.042.737	2008	108.674	2008	1.790.059
2009	1.042.737	2009	108.674	2009	1.790.059
2010	1.128.683	2010	112.969	2010	1.842.982
2011	1.206.209	2011	117.433	2011	1.888.388
2012	1.289.059	2012	122.074	2012	1.934.914
2013	1.377.600	2013	126.898	2013	1.982.585
2014	1.472.223	2014	131.912	2014	2.031.431
2015	1.573.345	2015	137.125	2015	2.081.480
2016	1.659.800	2016	142.544	2016	2.122.507
2017	1.751.004	2017	148.177	2017	2.164.341
2018	1.847.221	2018	154.033	2018	2.207.000
2019	1.948.725	2019	160.120	2019	2.250.500
2020	2.055.806	2020	166.447	2020	2.294.858
2021	2.140.530	2021	173.025	2021	2.328.782
2022	2.228.745	2022	179.862	2022	2.363.207
2023	2.320.596	2023	186.970	2023	2.398.141
2024	2.416.233	2024	194.358	2024	2.433.592
2025	2.515.811	2025	202.039	2025	2.469.566
2026	2.619.492	2026	210.023	2026	2.506.073
2027	2.727.447	2027	218.322	2027	2.543.119
2028	2.839.850	2028	226.950	2028	2.580.712
2029	2.956.886	2029	235.918	2029	2.618.862
2030	3.078.745	2030	245.241	2030	2.657.575

Table 98: Total generation of industrial and non household waste for EU, in tonnes

EU	tonnes
2006	2.806.533
2007	2.941.470
2008	2.941.470
2009	2.941.470
2010	3.084.634
2011	3.212.030
2012	3.346.046
2013	3.487.083
2014	3.635.567
2015	3.791.951
2016	3.924.850
2017	4.063.523
2018	4.208.254
2019	4.359.345
2020	4.517.111
2021	4.642.336
2022	4.771.814
2023	4.905.707
2024	5.044.182
2025	5.187.415
2026	5.335.587
2027	5.488.887
2028	5.647.512
2029	5.811.666
2030	5.981.561

Table 99: Generation of C&D waste, WWT sludge and other non household waste for yellow group of Member States

	generation (tonnes)			
yellow	C&D waste	WWT sludge	other	TOTAL
2005	14.643	3.399	871.937	**889.979**
2006	15.895	3.661	943.779	**963.335**
2007	51.049	4.028	987.659	**1.042.737**
2008	84.894	4.094	953.749	**1.042.737**
2009	118.738	4.160	919.839	**1.042.737**
2010	165.159	4.574	958.950	**1.128.683**
2011	215.653	4.965	985.591	**1.206.209**
2012	272.305	5.387	1.011.368	**1.289.059**
2013	335.721	5.844	1.036.035	**1.377.600**
2014	406.565	6.338	1.059.320	**1.472.223**
2015	485.557	6.873	1.080.915	**1.573.345**
2016	566.110	7.356	1.086.334	**1.659.800**
2017	654.050	7.870	1.089.084	**1.751.004**
2018	749.945	8.419	1.088.856	**1.847.221**
2019	854.404	9.005	1.085.315	**1.948.725**
2020	968.079	9.630	1.078.097	**2.055.806**
2021	1.007.975	10.162	1.122.392	**2.140.530**
2022	1.049.516	10.721	1.168.508	**2.228.745**
2023	1.092.769	11.310	1.216.518	**2.320.596**
2024	1.137.804	11.929	1.266.500	**2.416.233**
2025	1.184.695	12.579	1.318.536	**2.515.811**
2026	1.233.519	13.097	1.372.876	**2.619.492**
2027	1.284.355	13.637	1.429.455	**2.727.447**
2028	1.337.285	14.199	1.488.366	**2.839.850**
2029	1.392.398	14.784	1.549.704	**2.956.886**
2030	1.449.781	15.394	1.613.570	**3.078.745**

Table 100: Generation of C&D waste, WWT sludge and other non household waste for turquoise group of Member States

turquoise	C&D waste	WWT sludge	other	TOTAL
2005	20.147	2.119	78.303	**100.569**
2006	20.940	2.206	81.397	**104.543**
2007	23.868	2.201	82.605	**108.674**
2008	25.969	2.109	80.597	**108.674**
2009	28.069	2.017	78.589	**108.674**
2010	31.362	2.001	79.606	**112.969**
2011	34.871	1.980	80.582	**117.433**
2012	38.608	1.955	81.510	**122.074**
2013	42.587	1.925	82.386	**126.898**
2014	46.820	1.889	83.204	**131.912**
2015	51.320	1.848	83.958	**137.125**
2016	56.103	1.800	84.641	**142.544**
2017	61.184	1.745	85.247	**148.177**
2018	66.579	1.684	85.769	**154.033**
2019	72.305	1.615	86.199	**160.120**
2020	78.380	1.537	86.530	**166.447**
2021	81.477	1.452	90.096	**173.025**
2022	84.697	1.357	93.808	**179.862**
2023	88.044	1.252	97.674	**186.970**
2024	91.523	1.136	101.698	**194.358**
2025	95.140	1.010	105.888	**202.039**
2026	98.900	1.050	110.073	**210.023**
2027	102.808	1.092	114.423	**218.322**
2028	106.871	1.135	118.944	**226.950**
2029	111.094	1.180	123.645	**235.918**
2030	115.484	1.226	128.531	**245.241**

Table 101: Generation of C&D waste, WWT sludge and other non household waste for lavender group of Member States

lavender	C&D waste	WWT sludge	other	TOTAL
2005	795.162	8.519	885.047	**1.688.728**
2006	818.733	8.693	911.229	**1.738.655**
2007	842.939	8.950	938.170	**1.790.059**
2008	842.939	8.950	938.170	**1.790.059**
2009	842.939	8.950	938.170	**1.790.059**
2010	867.860	9.215	965.907	**1.842.982**
2011	889.242	9.442	989.704	**1.888.388**
2012	911.151	9.675	1.014.088	**1.934.914**
2013	933.599	9.913	1.039.073	**1.982.585**
2014	956.601	10.157	1.064.673	**2.031.431**
2015	980.169	10.407	1.090.904	**2.081.480**
2016	999.488	10.613	1.112.406	**2.122.507**
2017	1.019.188	10.822	1.134.331	**2.164.341**
2018	1.039.276	11.035	1.156.689	**2.207.000**
2019	1.059.761	11.253	1.179.487	**2.250.500**
2020	1.080.649	11.474	1.202.735	**2.294.858**
2021	1.096.623	11.644	1.220.514	**2.328.782**
2022	1.112.834	11.816	1.238.557	**2.363.207**
2023	1.129.285	11.991	1.256.866	**2.398.141**
2024	1.145.978	12.168	1.275.445	**2.433.592**
2025	1.162.919	12.348	1.294.300	**2.469.566**
2026	1.180.110	12.530	1.313.433	**2.506.073**
2027	1.197.555	12.716	1.332.848	**2.543.119**
2028	1.215.257	12.904	1.352.551	**2.580.712**
2029	1.233.222	13.094	1.372.545	**2.618.862**
2030	1.251.452	13.288	1.392.835	**2.657.575**

Table 102: Generation of C&D waste, WWT sludge and other non household waste for EU

EU	C&D waste	WWT sludge	other	TOTAL
2005	829.952	14.037	1.835.287	2.679.276
2006	855.568	14.560	1.936.406	2.806.533
2007	917.856	15.179	2.008.434	2.941.470
2008	953.801	15.153	1.972.516	2.941.470
2009	989.746	15.127	1.936.597	2.941.470
2010	1.064.381	15.790	2.004.464	3.084.634
2011	1.139.766	16.387	2.055.878	3.212.030
2012	1.222.064	17.017	2.106.966	3.346.046
2013	1.311.907	17.682	2.157.494	3.487.083
2014	1.409.985	18.385	2.207.197	3.635.567
2015	1.517.046	19.128	2.255.777	3.791.951
2016	1.621.702	19.768	2.283.380	3.924.850
2017	1.734.423	20.437	2.308.662	4.063.523
2018	1.855.801	21.138	2.331.314	4.208.254
2019	1.986.470	21.872	2.351.002	4.359.345
2020	2.127.107	22.642	2.367.362	4.517.111
2021	2.186.076	23.257	2.433.002	4.642.336
2022	2.247.047	23.894	2.500.873	4.771.814
2023	2.310.097	24.552	2.571.057	4.905.707
2024	2.375.305	25.233	2.643.644	5.044.182
2025	2.442.754	25.937	2.718.724	5.187.415
2026	2.512.528	26.678	2.796.381	5.335.587
2027	2.584.717	27.444	2.876.726	5.488.887
2028	2.659.413	28.238	2.959.861	5.647.512
2029	2.736.713	29.058	3.045.894	5.811.666
2030	2.816.717	29.908	3.134.936	5.981.561

Table 103: Landfill of non household/industrial waste for yellow group of Member States

yellow	landfilled	landfilled C&D waste	landfilled cumulative	landfilled C&D cumulative
2005	643.663	14.484	643.663	14.484
2006	696.717	15.678	1.340.380	30.163
2007	716.926	41.143	2.057.306	71.306
2008	676.617	65.082	2.733.922	136.388
2009	640.457	89.020	3.374.380	225.408
2010	654.082	122.269	4.028.462	347.676
2011	638.911	146.899	4.667.373	494.575
2012	639.161	162.090	5.306.535	656.665
2013	628.126	178.675	5.934.660	835.340
2014	606.622	196.773	6.541.282	1.032.113
2015	583.865	216.515	7.125.148	1.248.628
2016	545.563	232.630	7.670.710	1.481.258
2017	483.707	233.423	8.154.417	1.714.681
2018	434.884	233.805	8.589.301	1.948.486
2019	376.923	251.512	8.966.224	2.199.999
2020	297.238	308.091	9.263.462	2.508.090
2021	303.610	300.755	9.567.072	2.808.845
2022	314.091	313.150	9.881.162	3.121.995
2023	298.297	305.112	10.179.460	3.427.107
2024	308.022	317.686	10.487.481	3.744.793
2025	315.431	308.074	10.802.913	4.052.866
2026	301.359	320.770	11.104.272	4.373.636
2027	312.484	309.374	11.416.756	4.683.011
2028	325.362	322.124	11.742.117	5.005.135
2029	338.770	308.714	12.080.888	5.313.849
2030	352.732	321.436	12.433.620	5.635.285

Table 104: Landfill of non household/industrial waste for turquoise group of Member States

turquoise	landfilled	landfilled C&D waste	landfilled cumulative	landfilled C&D cumulative
2005	39.607	18.851	39.607	18.851
2006	41.172	19.596	80.780	38.447
2007	39.886	22.319	120.666	60.767
2008	37.662	23.904	158.327	84.671
2009	35.426	24.972	193.753	109.642
2010	34.487	27.069	228.240	136.711
2011	32.169	28.177	260.409	164.889
2012	30.866	28.171	291.275	193.060
2013	29.401	28.121	320.677	221.180
2014	27.075	28.022	347.752	249.202
2015	23.820	27.872	371.572	277.074
2016	21.429	27.389	393.001	304.463
2017	18.855	25.473	411.856	329.936
2018	16.072	23.419	427.928	353.355
2019	10.761	22.684	438.689	376.039
2020	7.450	24.944	446.139	400.983
2021	7.100	24.311	453.239	425.294
2022	6.644	25.272	459.883	450.565
2023	6.047	24.583	465.929	475.148
2024	5.323	25.554	471.252	500.702
2025	4.412	24.741	475.664	525.443
2026	4.587	25.718	480.251	551.161
2027	4.768	24.764	485.019	575.926
2028	4.957	25.743	489.976	601.669
2029	5.152	24.631	495.128	626.300
2030	5.356	25.604	500.484	651.904

Table 105: Landfill of non household/industrial waste for lavender group of Member States

lavender	landfilled	landfilled C&D waste	landfilled cumulative	landfilled C&D cumulative
2005	376.802	317.898	376.802	317.898
2006	387.942	327.296	764.744	645.194
2007	380.394	332.772	1.145.138	977.966
2008	379.195	332.772	1.524.333	1.310.738
2009	377.536	332.772	1.901.869	1.643.510
2010	387.244	342.610	2.289.113	1.986.120
2011	393.842	333.112	2.682.955	2.319.232
2012	382.389	341.319	3.065.344	2.660.551
2013	389.396	349.728	3.454.740	3.010.279
2014	396.737	358.344	3.851.477	3.368.623
2015	403.576	347.399	4.255.053	3.716.022
2016	382.576	350.704	4.637.629	4.066.726
2017	382.903	354.004	5.020.532	4.420.730
2018	383.089	357.298	5.403.621	4.778.028
2019	382.885	360.584	5.786.506	5.138.612
2020	382.249	343.916	6.168.755	5.482.529
2021	361.204	348.223	6.529.959	5.830.751
2022	361.462	353.370	6.891.421	6.184.122
2023	361.157	358.594	7.252.578	6.542.716
2024	360.213	363.895	7.612.791	6.906.611
2025	335.087	369.274	7.947.878	7.275.885
2026	340.041	352.116	8.287.919	7.628.001
2027	345.067	357.321	8.632.986	7.985.321
2028	350.168	362.603	8.983.154	8.347.924
2029	330.466	367.963	9.313.620	8.715.888
2030	335.351	373.403	9.648.971	9.089.290

Table 106: Landfill of non household/industrial waste for EU

EU	landfilled	landfilled C&D waste	landfilled cumulative	landfilled C&D cumulative
2005	1.060.073	351.233	1.060.073	351.233
2006	1.125.831	362.571	2.185.904	713.804
2007	1.137.205	396.235	3.323.109	1.110.039
2008	1.093.473	421.757	4.416.583	1.531.796
2009	1.053.419	446.764	5.470.002	1.978.560
2010	1.075.813	491.948	6.545.815	2.470.508
2011	1.064.923	508.188	7.610.738	2.978.696
2012	1.052.416	531.580	8.663.154	3.510.276
2013	1.046.923	556.523	9.710.077	4.066.799
2014	1.030.434	583.140	10.740.511	4.649.939
2015	1.011.262	591.786	11.751.773	5.241.724
2016	949.568	610.723	12.701.340	5.852.448
2017	885.465	612.899	13.586.806	6.465.347
2018	834.045	614.522	14.420.850	7.079.869
2019	770.568	634.780	15.191.419	7.714.650
2020	686.937	676.952	15.878.355	8.391.601
2021	671.914	673.289	16.550.269	9.064.890
2022	682.197	691.792	17.232.466	9.756.682
2023	665.500	688.289	17.897.967	10.444.971
2024	673.557	707.135	18.571.524	11.152.106
2025	654.931	702.088	19.226.455	11.854.194
2026	645.987	698.604	19.872.442	12.552.798
2027	662.319	691.459	20.534.761	13.244.258
2028	680.487	710.470	21.215.248	13.954.728
2029	674.388	701.308	21.889.636	14.656.036
2030	693.439	720.443	22.583.074	15.376.479

Table 107: Incineration of non household/ industrial waste in different groups of Member States

yellow	incinerated	turquoise	incinerated	lavender	incinerated
2005	7.832	2005	3.791	2005	114.158
2006	8.477	2006	3.941	2006	117.533
2007	9.385	2007	4.347	2007	125.304
2008	10.427	2008	4.347	2008	125.304
2009	10.427	2009	4.347	2009	125.304
2010	11.287	2010	4.519	2010	129.009
2011	18.093	2011	4.697	2011	132.187
2012	19.336	2012	4.883	2012	135.444
2013	27.552	2013	5.076	2013	138.781
2014	29.444	2014	5.936	2014	142.200
2015	39.334	2015	6.171	2015	145.704
2016	49.296	2016	6.350	2016	147.090
2017	60.059	2017	6.535	2017	148.474
2018	71.672	2018	6.724	2018	149.855
2019	84.185	2019	7.686	2019	151.234
2020	97.651	2020	7.906	2020	152.608
2021	101.675	2021	8.219	2021	154.864
2022	105.865	2022	8.543	2022	157.153
2023	110.228	2023	8.881	2023	159.476
2024	114.771	2024	9.232	2024	161.834
2025	119.501	2025	9.597	2025	164.226
2026	124.426	2026	9.976	2026	166.654
2027	129.554	2027	10.370	2027	169.117
2028	134.893	2028	10.780	2028	171.617
2029	140.452	2029	11.206	2029	174.154
2030	146.240	2030	11.649	2030	176.729

Table 108: Incineration of non household/ industrial waste in EU

EU	incineration
2005	125.781
2006	129.952
2007	139.036
2008	140.078
2009	140.078
2010	144.814
2011	154.978
2012	159.663
2013	171.409
2014	177.581
2015	191.208
2016	202.736
2017	215.068
2018	228.251
2019	243.104
2020	258.165
2021	264.758
2022	271.562
2023	278.586
2024	285.837
2025	293.324
2026	301.056
2027	309.041
2028	317.290
2029	325.813
2030	334.618

Table 109: Recycling of non household/industrial waste in yellow group of Member States

yellow	paper cardboard	plastic	glass	metals	C&D	other
2005	1.116	392	851	11.749	167	208.114
2006	1.208	424	922	12.718	181	225.267
2007	2.085	521	1.043	14.598	10.427	245.043
2008	2.085	521	1.043	14.598	20.855	250.257
2009	3.128	521	1.043	15.641	31.282	250.257
2010	4.515	564	2.257	16.930	45.147	270.884
2011	6.031	724	2.412	19.299	72.373	301.552
2012	7.734	902	2.578	20.625	116.015	322.265
2013	9.643	1.102	2.755	23.419	165.312	344.400
2014	11.778	1.325	2.944	25.028	220.833	382.778
2015	14.160	1.573	4.720	28.320	283.202	409.070
2016	16.432	1.972	4.930	29.578	345.072	427.232
2017	18.876	2.402	5.148	32.604	428.996	463.316
2018	21.502	2.867	5.375	34.044	519.623	483.787
2019	24.320	3.367	7.483	37.416	598.648	505.109
2020	27.342	3.906	7.812	39.060	643.772	546.844
2021	30.503	4.474	8.134	42.704	691.391	569.381
2022	31.760	5.082	8.469	44.463	719.885	592.846
2023	33.068	5.732	11.023	48.500	771.598	639.324
2024	34.431	6.427	11.477	50.499	803.397	665.672
2025	35.850	7.170	11.950	54.970	860.407	693.106
2026	37.328	7.466	12.443	57.236	895.866	746.555
2027	38.866	7.773	12.955	59.595	958.698	777.322
2028	40.468	8.094	13.489	62.051	998.207	809.357
2029	42.136	8.427	14.045	64.608	1.067.436	842.713
2030	43.872	8.774	14.624	67.271	1.111.427	877.442

Table 110: Recycling of non household/industrial waste in turquoise group of Member States

turquoise	paper cardboard	plastic	glass	metals	C&D	other
2005	1.581	175	457	6.913	1.364	26.859
2006	1.644	182	475	7.186	1.418	27.921
2007	1.706	196	489	7.607	1.630	29.342
2008	1.706	196	489	7.607	2.173	29.342
2009	1.695	206	489	7.607	3.260	29.342
2010	1.762	215	508	7.908	4.519	30.502
2011	1.820	235	587	8.220	7.046	32.881
2012	1.892	256	610	8.545	10.987	34.181
2013	1.954	279	634	8.883	15.228	35.531
2014	2.031	303	660	9.234	19.787	36.935
2015	2.098	329	686	9.599	24.683	39.766
2016	2.159	353	706	9.878	29.635	40.924
2017	2.207	378	726	10.165	36.303	42.112
2018	2.271	388	747	10.459	43.329	43.329
2019	2.321	415	769	10.760	49.189	46.114
2020	2.388	427	791	11.069	52.123	47.437
2021	2.466	460	822	11.506	55.887	49.312
2022	2.563	478	854	11.961	58.095	51.261
2023	2.664	515	888	12.433	62.167	53.286
2024	2.770	535	923	12.925	64.624	55.392
2025	2.879	576	960	13.436	69.097	57.581
2026	2.993	599	998	13.967	71.828	59.856
2027	3.111	622	1.037	14.518	76.740	62.222
2028	3.234	647	1.078	15.092	79.773	64.681
2029	3.362	672	1.121	15.689	85.166	67.237
2030	3.495	699	1.165	16.309	88.532	69.894

Table 111: Recycling of non household/industrial waste in lavender group of Member States

lavender	paper cardboard	plastic	glass	metals	C&D	other
2005	22.709	1.900	7.369	35.626	502.383	326.257
2006	23.380	1.956	7.587	36.679	517.236	335.903
2007	25.061	2.148	8.055	37.949	537.018	358.012
2008	25.061	2.327	8.055	37.949	537.018	358.012
2009	25.061	2.506	8.234	38.128	537.018	358.012
2010	25.802	2.764	8.478	39.256	552.895	368.596
2011	27.382	3.021	8.875	40.412	585.400	377.678
2012	28.056	3.289	9.094	41.407	599.823	406.332
2013	28.747	3.569	9.516	42.626	614.601	416.343
2014	29.456	3.860	9.751	43.676	629.744	426.601
2015	30.181	4.163	10.199	44.960	666.074	437.111
2016	31.519	4.413	10.296	45.388	672.410	462.282
2017	31.816	4.666	10.605	45.815	678.737	466.632
2018	32.112	4.924	10.704	46.241	685.053	470.974
2019	32.407	5.185	10.802	46.666	691.354	475.306
2020	32.702	5.450	10.901	47.090	718.631	479.625
2021	33.185	5.752	11.062	47.787	730.073	508.839
2022	33.676	6.062	11.225	48.493	740.865	516.361
2023	34.174	6.379	11.391	49.210	751.817	523.994
2024	34.679	6.705	11.560	49.937	762.931	531.740
2025	35.191	7.038	11.730	50.675	774.209	563.061
2026	35.712	7.142	11.904	51.425	809.461	571.385
2027	36.239	7.248	12.080	52.185	821.427	579.831
2028	36.775	7.355	12.258	52.956	833.570	588.402
2029	37.319	7.464	12.440	53.739	845.892	621.980
2030	37.870	7.574	12.623	54.533	858.397	631.174

Table 112: Recycling of non household/industrial waste in EU

EU	paper cardboard	plastic	glass	metals	C&D	other
2005	25.406	2.467	8.678	54.288	503.914	561.230
2006	26.232	2.562	8.984	56.583	518.835	589.091
2007	28.852	2.865	9.587	60.155	549.075	632.397
2008	28.852	3.044	9.587	60.155	560.046	637.611
2009	29.884	3.234	9.766	61.377	571.560	637.611
2010	32.079	3.543	11.243	64.094	602.561	669.982
2011	35.233	3.980	11.875	67.931	664.819	712.111
2012	37.683	4.448	12.283	70.577	726.825	762.777
2013	40.345	4.950	12.906	74.928	795.141	796.274
2014	43.265	5.488	13.355	77.937	870.364	846.314
2015	46.440	6.065	15.605	82.879	973.958	885.947
2016	50.110	6.737	15.931	84.844	1.047.117	930.439
2017	52.899	7.446	16.479	88.583	1.144.037	972.060
2018	55.885	8.179	16.826	90.744	1.248.006	998.090
2019	59.048	8.968	19.054	94.842	1.339.191	1.026.530
2020	62.432	9.783	19.503	97.220	1.414.526	1.073.907
2021	66.153	10.686	20.018	101.996	1.477.351	1.127.532
2022	67.998	11.622	20.549	104.917	1.518.845	1.160.468
2023	69.906	12.626	23.302	110.144	1.585.583	1.216.604
2024	71.880	13.667	23.960	113.361	1.630.952	1.252.804
2025	73.921	14.784	24.640	119.082	1.703.713	1.313.748
2026	76.032	15.206	25.344	122.627	1.777.155	1.377.796
2027	78.217	15.643	26.072	126.298	1.856.865	1.419.375
2028	80.477	16.095	26.826	130.099	1.911.550	1.462.440
2029	82.816	16.563	27.605	134.036	1.998.495	1.531.929
2030	85.237	17.047	28.412	138.113	2.058.356	1.578.510

Table 113: Export in different groups of Member States

yellow		turquoise		lavender	
2005	1.618	2005	1.038	2005	8.745
2006	1.752	2006	1.079	2006	9.004
2007	2.086	2007	1.234	2007	10.197
2008	2.294	2008	1.357	2008	11.217
2009	2.524	2009	1.493	2009	12.338
2010	3.005	2010	1.707	2010	13.973
2011	3.533	2011	1.952	2011	15.750
2012	4.153	2012	2.232	2012	17.751
2013	4.882	2013	2.552	2013	20.008
2014	5.739	2014	2.918	2014	22.551
2015	6.746	2015	3.337	2015	25.417
2016	7.829	2016	3.815	2016	28.509
2017	9.085	2017	4.363	2017	31.979
2018	10.542	2018	4.988	2018	35.870
2019	12.234	2019	5.704	2019	40.234
2020	14.196	2020	6.523	2020	45.130
2021	16.260	2021	7.458	2021	50.377
2022	18.623	2022	8.528	2022	56.234
2023	21.329	2023	9.752	2023	62.772
2024	24.429	2024	11.151	2024	70.070
2025	27.979	2025	12.751	2025	78.216
2026	31.434	2026	13.255	2026	79.372
2027	34.093	2027	13.778	2027	80.545
2028	35.498	2028	14.323	2028	81.736
2029	36.961	2029	14.889	2029	82.944
2030	38.484	2030	15.477	2030	84.170

Table 114: Export in EU

EU	export
2005	11.401
2006	11.834
2007	13.516
2008	14.868
2009	16.355
2010	18.685
2011	21.234
2012	24.136
2013	27.441
2014	31.207
2015	35.499
2016	40.153
2017	45.426
2018	51.400
2019	58.172
2020	65.849
2021	74.095
2022	83.385
2023	93.853
2024	105.650
2025	118.946
2026	124.061
2027	128.417
2028	131.557
2029	134.794
2030	138.132

Annex 6: ELCD data on CO2 and CH4 production emissions

Table 115: ELCD data on CO2 and CH4 production emissions for minerals

GHG related production emissions per kg material	carbon dioxide	methane
Process data set: Crushed stone 16/32; open pit mining; production mix, at plant; undried (en)	0.013 kg (Mass)	2.340-5 kg (Mass)
Process data set: Gravel 2/32; wet and dry quarry; production mix, at plant; undried (en)	0.00323kg (Mass)	5.487E-6 kg (Mass)
Process data set: Gypsum plaster (CaSO4 beta hemihydrates); technology mix of natural gypsum (45%) and gypsum from flue gas desulphurisation (55%); production mix, at plant; grinded and purified product (en)	0.100978 kg (Mass)	0.000234 kg (Mass)
Process data set: Gypsum stone (CaSO4-dihydrate); underground and open pit mining; production mix, at plant; grinded and purified product (en)	0.00238 kg (Mass)	3.563E-6 kg (Mass)
Process data set: Portland cement (CEM I); CEMBUREAU technology mix, EN 197-1; CEMBUREAU production mix, at plant; (en)	0.885 kg (Mass)	0.000580 kg (Mass)
Process data set: Sand 0/2; wet and dry quarry; production mix, at plant; undried (en)	0.00234 kg (Mass)	5.255E-10 kg (Mass)

Table 116: ELCD data on CO2 and CH4 production emissions for wood

GHG related production emissions per kg material	carbon dioxide	methane
Process data set: Pine log with bark; refostered managed forest; production mix entry to saw mill, at plant; 44% water content (en)	0.00647 kg (Mass)	8.278E-6 kg (Mass)
Process data set: Pine wood; timber; production mix, at saw mill; 40% water content (en)	0.0239 kg (Mass)	3.734E-5 kg (Mass)

Process data set: Spruce log with bark; refostered managed forest; production mix entry to saw mill, at plant; 44% water content (en)	0.00682 kg (Mass)	8.292E-6 kg (Mass)
Process data set: Spruce wood; timber; production mix, at saw mill; 40% water content (en)	0.02556 kg (Mass)	4.0429E-5 kg (Mass)

Table 117: ELCD data on CO2 and CH4 production emissions for fuels

GHG related production emissions per kg material	carbon dioxide	methane
Process data set: Diesel; from crude oil; consumption mix, at refinery; 200 ppm sulphur (en)	0.301 kg (Mass)	0.00336 kg (Mass)
Process data set: Gasoline (regular); from crude oil; consumption mix, at refinery; 100 ppm sulphur (en)	0.593 kg (Mass)	0.00361 kg (Mass)
Process data set: Heavy fuel oil; from crude oil; consumption mix, at refinery; (en)	0.269 kg (Mass)	0.002944 kg (Mass)
Process data set: Kerosene; from crude oil; consumption mix, at refinery; 700 ppm sulphur (en)	0.259 kg (Mass)	0.00330 kg (Mass)
Process data set: Light fuel oil; from crude oil; consumption mix, at refinery; 2000 ppm sulphur (en)	0.301 kg (Mass)	0.00335 kg (Mass)
Process data set: Natural Gas; from onshore and offshore production incl. pipeline and LNG transport; consumption mix, at consumer; desulphurised (en)	0.286 kg (Mass)	0.00691 kg (Mass)
Process data set: Hard Coal; from underground and open pit mining; consumption mix, at power plant; (en)	0.106 kg (Mass)	0.00793 kg (Mass)
Process data set: Lignite; from open pit mining; consumption mix, at power plant; (en)	0.0175 kg (Mass)	0.000748 kg (Mass)

Table 118: ELCD data on CO2 and CH4 production emissions for metals

GHG related production emissions per kg material	carbon dioxide	methane
Process data set: Aluminum extrusion profile; primary production; production mix, at plant; aluminum semi-finished extrusion product, including primary production, transformation and recycling (en)	2.212 kg (Mass)	0.00419 kg (Mass)
Process data set: Aluminum sheet; primary production; production mix, at plant; aluminum semi-finished sheet product, including primary production, transformation and recycling (en)	2.865 kg (Mass)	0.00520 kg (Mass)
Process data set: Copper sheet; technology mix; consumption mix, at plant; 0,6 mm thickness (en)	0.921 kg (Mass)	0.00184 kg (Mass)
Process data set: Copper tube; technology mix; consumption mix, at plant; diameter 15 mm, 1 mm thickness (en)	0.927 kg (Mass)	0.00188 kg (Mass)
Process data set: Copper wire; technology mix; consumption mix, at plant; cross section 1 mmy (en)	0.745 kg (Mass)	0.00155 kg (Mass)
Process data set: Lead; primary; consumption mix, at plant; (en)	1.694 kg (Mass)	0.00306 kg (Mass)
Process data set: Special high grade zinc; primary production; production mix, at plant; (en)	3.040 kg (Mass)	0.00395 kg (Mass)
Process data set: Steel hot rolled coil; blast furnace route; production mix, at plant; thickness 2 to 7 mm, width 600 to 2100 mm (en)	0.898 kg (Mass)	0.000705 kg (Mass)
Process data set: Steel hot rolled section; blast furnace and electric arc furnace route; production mix, at plant; (en)	1.0997 kg (Mass)	0.000719 kg (Mass)
Process data set: Steel rebar; blast furnace and electric arc furnace route; production mix, at plant; (en)	1.00188 kg (Mass)	0.000578 kg (Mass)

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