ISWA Key Issue Paper on Waste Prevention, Waste Minimization and Resource Management

1. Introduction

Waste management has undergone many changes since the 1960s. These changes include a key role for political guidance, the development of the waste hierarchy as a strategic basis for waste management planning, a political definition of waste to cover all items and materials to be discarded, the use of advanced and new technologies, an increased interest of commercial companies for business opportunities and an enhanced status in terms of professional and industry status. Behind these changes there are many political, societal and scientific development patterns; such issues as an increased awareness of needs for environmental protection and better management of limited natural resources, rapid global population growth and urbanization, a necessity to support developing countries, an increasing transition towards consumerism societies based on global markets, new material and product innovations, and telecommunication development enabling the availability of information throughout the world. Already in the 1970´s the most industrialized countries responded politically to these patterns by combining sanitation, environmental protection and mainly commercial and charity based existing recycling and reuse practices into the modern waste management. Particularly through UN processes modern waste management practices have become one of the key areas in targeting sustainability.

Today, despite many achievements in waste management, there are still several challenges to be resolved. A major challenge is to integrate modern waste management as an integral aspect of material and energy flows management. Accordingly, there is an obvious need for advanced information management based on a coherent conceptual understanding of the systems we are dealing with. We need improved capability to identify the real ecological and social benefits which we are targeting through our management and engineering solutions. In particular, waste prevention, the top of the waste hierarchy, calls for a transparent identification of key players with their respective interests and operational limitations. The waste industry has an important role to support, facilitate and maybe even drive waste prevention activities.

2. Challenges to be faced

The global extraction of natural resources such as minerals, metals, biomass and fossil energy carriers, is steadily increasing showing a near exponential growth. As shown in

Figure 1 the increase from 1980 to 2007 (i.e. 27 a) was only 62 % (from 38 to $62 \cdot 10^9$ t). However, in the period from 2007 to 2010 (i.e. only 3 a) the increase accounted for 32 % (from 62 to $81 \cdot 10^9$ t) even if the time was only one tenth. By 2030 it is expected that the amount of global extraction will be more than doubled (from 62 to $130 \cdot 10^9$ t) compared to 2007 or range at 2.4 times compared to 1980.

Parallel to the distinct increase in global extraction the share of various regions is significantly altering. Figure 2 illustrates that the share of Asia (1980: 36 %; 2007: 45 %; i.e. + 24 %) is increasing while at the same time the percentage of extraction in Europe (1980: 18 %; 2007: 11 %; i.e. - 36 %) and North America (1980: 23 %; 2007: 17 %; i.e. - 24 %) is decreasing.

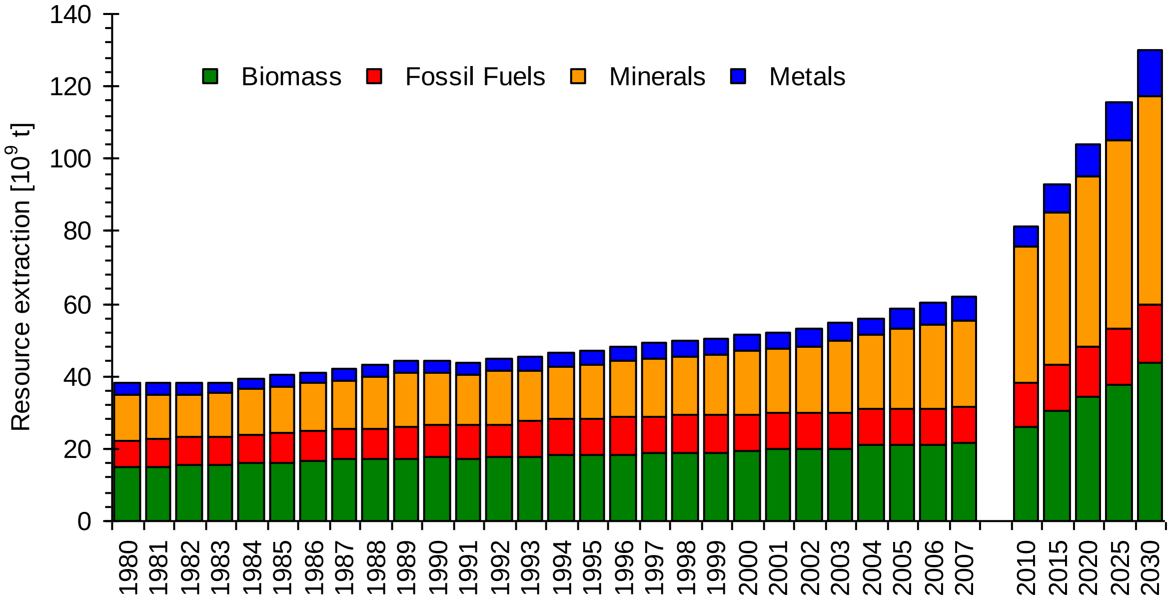


Figure 1: Global resource extraction, by major groups of resources[1]

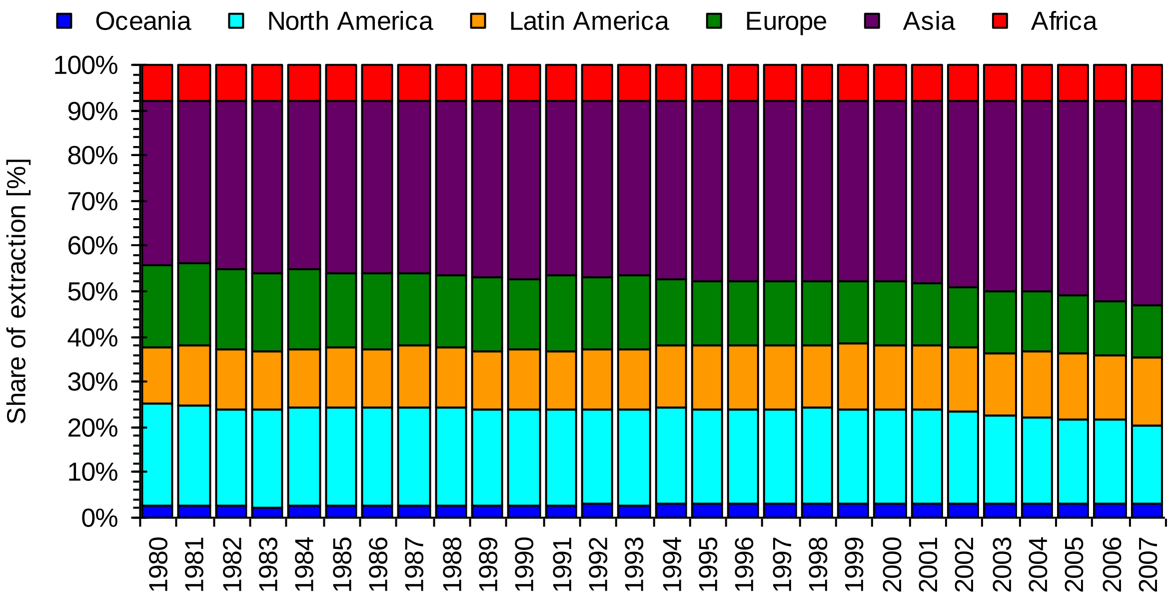


Figure 2: Global resource extraction, by major regions[1]

A recent study from UNEP on the impacts of consumption and production shows that materials are important intermediaries of environmental impact. In developed countries material consumption has to a large extent stabilized. In developing countries, however, especially in rapidly growing economies such as India and China, material demand is rising rapidly. For many materials, scarcity problems are envisaged, which cannot be supplemented by secondary raw material production in the short term. The rapid increases in energy and metal prices are a clear indicator of the fact that the resource and energy supplies are not meeting demand.

[1] SERI - Nachhaltigkeitsforschungs und -kommunikations GmbH, www.seri.at, accessed 28th December 2010.

It seems that due to rising demand and declining ore grades the energy requirements of the production of metals from ore might increase to a very high level. Further, many proposed sustainable technologies for energy supply and mobility rely for a large part on the use of metals (e.g. applied in batteries, fuel cells and solar cells). The production implications of such novel infrastructure developments may hence be very energy-intensive and may lead to the scarcity of certain materials[2].

In a recent report from the EU, 41 minerals and metals have been analyzed for their importance to the economy and their supply risk according which the materials are plotted in Figure 3. The materials can be classified into the following three groups of:

1. Materials showing a relatively low economic importance as well as a relative low supply risk are situated in the left bottom of the chart (indicated by green triangles). Thus, these 14 materials seem not be crucial for the industry.
2. Materials showing a relatively high economic importance but a relative low supply risk are situated in the right bottom of the chart (indicated by blue circles). In spite of the economic relevance their abundance and/or their possibility of substitutability between materials means that these 12 materials are not crucial.
3. 14 Materials showing a relatively high economic importance as well as a relative high supply risk falling within the top right cluster of the chart are critical.

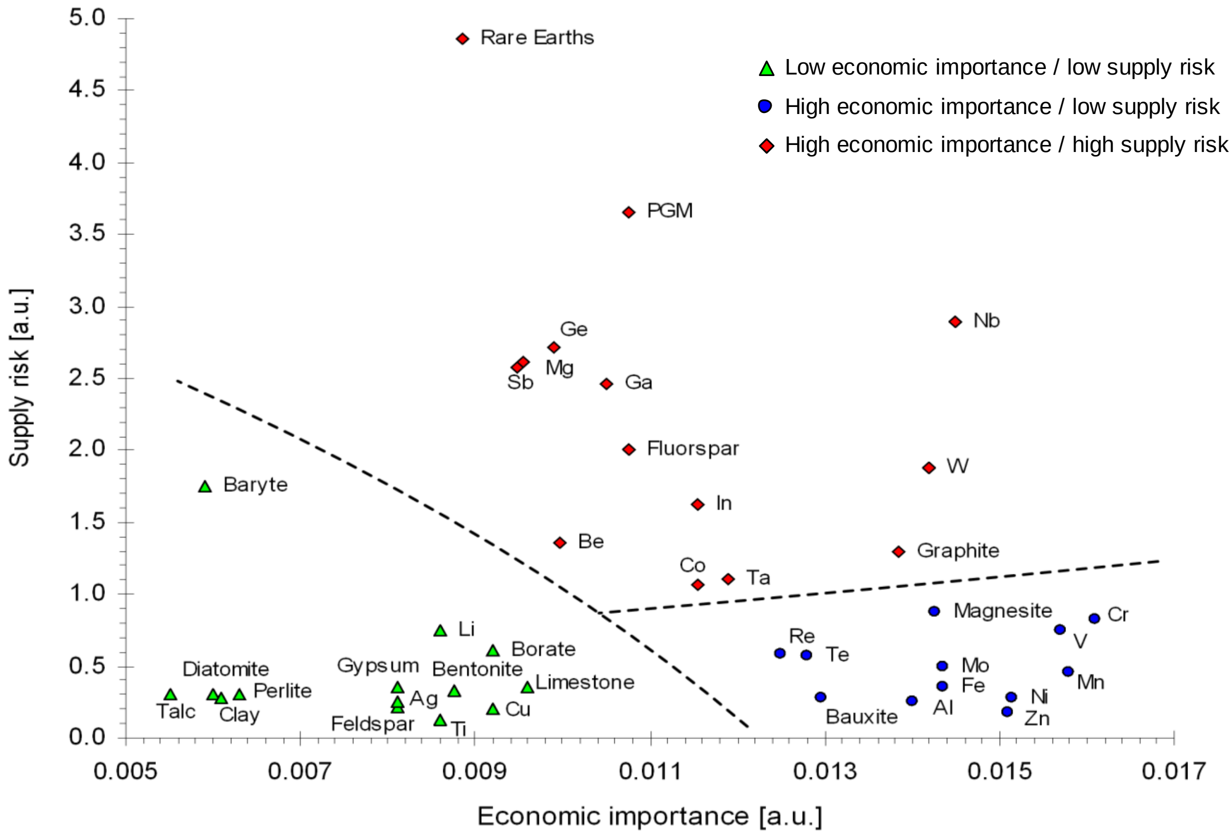


Figure 3: Economic importance and supply risk of 41 minerals and materials.

The current levels of recycling are not able to meet these demands and as long as the total demand for resources is still growing enhanced recycling is only a partial answer to resource scarcity. Contributing to this gap is the fact that increased consumption does not only lead to an increase in

[2] Assessing the Environmental Impacts of Consumption and Production: Priority Products and Materials; UNEP 2010.

waste and/or recoverable resources, but also to a significant increase in the stock of materials in society. These materials are in use in buildings, infrastructure and products and are in many cases not available for recovery for over a period of years or more often decades.

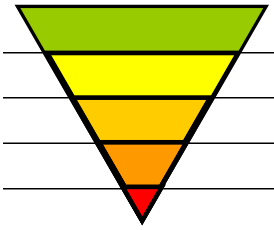
There are, of course, important social and political aspects connected to resource use and resource scarcity. Reserves of fossil fuels and metals are unevenly distributed across the world. The production of many materials is concentrated in a small number of countries, e.g. more than 90% of rare earths and antimony and more than 75% of germanium and tungsten are produced in China and more than 90% of niobium in Brazil and 77% of platinum in South-Africa. Securing reliable and undistorted access to natural resources has become a critical challenge to many resource-dependent countries all over the world. Access to natural resources will therefore be an important strategic political and economical asset.

Climate change, which is often regarded to be our biggest environmental challenge, is just one of the consequences of resource consumption. Our growing energy consumption, dominantly powered with fossil fuels is the main causes for climate change. The ISWA White Paper on Waste and Climate Change has shown that the waste sector has the potential of becoming a net carbon saver through enhanced recycling and energy recovery and the application of proven waste technologies. Waste prevention may have an even bigger positive impact on climate change since it could also help to reduce the production impacts of new consumer goods.

3. Framework

3.1 Waste hierarchy and life cycle thinking

The waste hierarchy has become a widely accepted guideline for waste management operations throughout the world, although the precise interpretation may vary from one place to another. The waste hierarchy stipulates a priority order in waste prevention and management legislation policy. Figure 4 shows the hierarchy according the directive 2008/98/EC which had to come into force in all EU countries in December 2010 the latest.



	Prevention	Avoid, reduce
	Preparing for re-use	Repair, clean, maintain
	Recycle	Material recycling / Feedstock recycling
	Other recovery	Energy recovery
	Disposal	Landfill

Figure 4 Waste hierarchy according the EU directive 2008/98/EC.

Although the waste hierarchy seems to be quite clear in practice several uncertainties exist. On the one hand the term recycling stands for a great variety of processes and methods which significantly differ in terms of environmental and economical benefit. The recycling of mixed plastic, as opposed to material separated plastic, for instance, has a very different environmental and economic impact. Generally speaking recycling operations which lead to materials with the same quality as the original have a better environmental performance than recycling operations which lead to materials with a lower quality. In the end the optimal form of recycling should however be decided based on a Life Cycle Assessment (LCA).

To reveal the overall impact of products and processes on the environment it has become clear that life-cycle thinking has to be applied. Choices in the stages of production and consumption affect the

environmental impact of a product as a whole and also the possibilities for later re-use or recycling. The waste hierarchy is useful for decisions in the waste phase, but only through life cycle thinking can a more comprehensive picture of the environmental performance of a product can be achieved. Decisions on the functionality of a product, the materials and resources from which they are made and their design should therefore be based on life cycle thinking. In these circumstances waste prevention and waste management may become resource management.

3.2 Resource management

Resource management means the process and policy of managing materials and energy throughout their life cycle with the aim to maximise the efficiency of material and energy utilisation and minimise loss of material as waste for disposal.

As shown in table 1 resource management is the broadest term and covers the complete chain from “cradle to cradle”. It can be seen as evolution of waste management. In contrast to waste management, which exclusively deals with the end-of-life phase, resource management is a holistic approach and covers a variety of actions. Waste is no longer in the foreground but any action or policy that results in material cycle process.

Table 1 presents a description of the waste management terms and definitions according to the waste hierarchy.

Table 1: Description of waste management terms according to the waste hierarchy and the EU Waste Framework Directive

Term			Description	Actions / examples
Resource management	Waste prevention	Prevention	Any action set **before** a product, substance or material has become waste. Aims to avoid or reduce waste in terms of quantity and quality (i.e. hazardous matters).	Avoiding the use of disposable utensils (e.g. napkin, packing) by customer. Eco-design: Development of products producing less waste (e.g. easy recyclability, long-life products). Cleaner production: Aims a continuous application of an integrated preventive environmental strategy applied to processes, products, and services to increase overall efficiency and reduce risks to humans and the environment (e.g. energy efficiency, internal recycling procedures).
		(preparing for) Re-use	Any operation by which products or components that are not waste **are used again for the same purpose** for which they were conceived.	Direct re-use of complete products (e.g. second hand clothes). Preparing for re-use: re-use after cleaning or repairing action (e.g. regrooved tires). Component re-use: Only re-use of parts of products (e.g. re-using an alternator from an end-of-life vehicle) including cleaning or repairing if necessary.
	Waste management	Recycling	Any recovery operation by which waste materials are **reprocessed** into products, materials or substances whether for the original or other purposes.	Product recycling: Any process in which the chemical and physical constitution of a product is maintained but the product is not used for the original purpose (e.g. using tires or glass bottles as building material). Material recycling: Any process in which the physical but not the chemical constitution is destroyed (e.g. melting and reprocessing of metals, or recycling of fertilizers from food-waste to the farming land by digestion or composting). Feedstock recycling (also raw material recycling or chemical recycling): Any process in which the physical as well as the chemical constitution of a material is reprocessed into its original constituants (e.g. de-polymerisation,). Downcycling: Any recycling process as mentioned above which results in a considerable lower product quality (e.g. recycled polymers).
		Other recovery	Any operation by which waste is serving a useful purpose by **replacing other materials**.	Thermal recovery: Incineration with a sufficient high energy recovery rate, gasification, pyrolysis. Digestion: Production of biogas from food-waste
		Disposal	Any operation which is not recovery	Incineration without or with low efficient energy recovery rate Landfill (under controlled conditions)

Although the waste hierarchy gives a clear priority order for different waste management methods, waste prevention can be further unraveled into different actions and methods relating to different stages in the chain of production and consumption. Figure 5 depicts the relationship of waste management methods and waste prevention as an aspect of resource management.

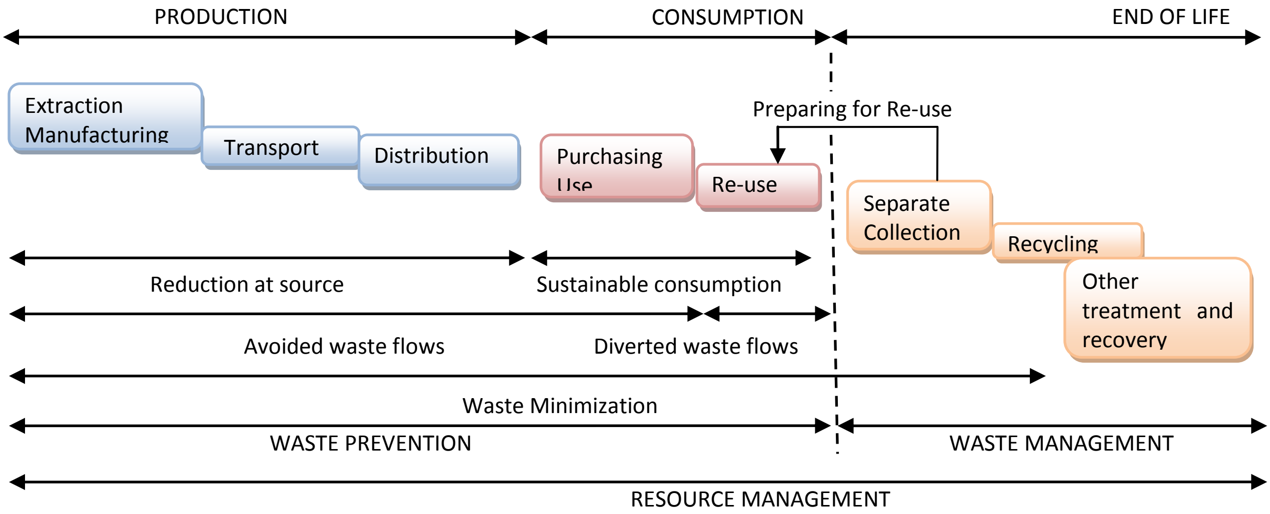


Figure 5: Relations of waste management and waste prevention as a part of resource management.

3.3 Driving forces

As shown in the previous chapter, a variety of methods exist for treating waste and end-of-life products. It is of importance to define the most relevant driving forces that influence the routes of waste and material streams.

Legislation plays an important role in the treatment of waste. Waste legislation originates from the desire to prevent sanitary problems and environmental pollution. Modern waste legislation, however, is aimed at turning waste into a resource. Regulations such as landfill bans for untreated waste and incineration bans for recyclable waste are tools to steer waste streams up the waste hierarchy.

Today many waste recovery activities are undertaken within the framework of extended producer responsibility which has become one of the most important instruments for enhancing and financing separate collection and recycling of different types of products and materials. Minimum recycling rates, which are usually part of a system of producer responsibility, can give a great push to the development of recycling methods. More recently legislation has been developing more in the direction of environmental product regulation, such as the EU RoHS Directive and the Eco-design Directive.

Economics is also an important driving force in influencing the direction of waste and material streams. It is clear that a recycling process will proceed without intervention if it is economically feasible. For instance, the recovery of noble metals from end-of-life catalytic converters is highly profitable and, thus, there is no need for legislation. On the other hand, even if legislation dictates recycling quotas, waste can be directed to illegal routes if no economically viable procedures for recycling and recovery are available. For instance, it has been reported that up to 75 % of end-of-life vehicles are illegally exported from the EU countries and, thus, circumventing the stringent European waste legislations to recover materials within the EU.

Environmental and *ethical* attitudes can significantly influence waste treatment. More and more consumers and producers are aware of their influence on the supply chain. Fair trade products exhibit an increasing demand even if their price is significantly higher than conventional products. Consumers and producers are becoming more and more aware of the circumstances in which their consumables are being produced. Products made in factories which do not apply minimum standards regarding safety and health, child labour, or minimum wages are no longer acceptable. However, the drive is still to be more aware of the quality of consumables (product quality as well as social and environmental quality), rather than the quantity. More sustainable consumption patterns would also entail consuming less and using more second hand products.

3.4 Globalization

Our economy is becoming more and more a global economy. Regional markets are steadily losing their importance and global markets are influencing the world's economy. Modern developed countries such as Japan, Canada and Europe have the most stringent regulations for waste. The workshop of the world, however, is located in China, India and South East Asia. Thus, the stringent regulation of waste in the developed countries only affects a relatively small share of the total production volume. A high degree of reuse and recycling in the more developed parts of the world therefore primarily affects (imported) end-consumer products, but not the significant portions of waste arising during the production processes in other parts of the world.

Furthermore, for economical reasons, a significant amount of discarded products (basically electrical and electronic waste and end near of life vehicles) are shipped to less developed countries for the purpose of re-use. In these countries these products will sooner rather than later, become waste. Because the more advanced treatment and recycling methods for these devices are lacking in the countries concerned, the end-of-life products will in many cases be discarded on unregulated dumps or perhaps be processed with poor technology. This leads to a loss of potentially recoverable valuable resources, to severe health problems for the workers involved and to environmental pollution.

Lastly, there is a great demand for resources in the producing countries. The consuming countries therefore ship increasing proportions of their waste to the producing countries for recovery. However, due to a lack of technically and economically sound recovery solutions considerable portions of this waste receive a sub-optimal treatment which also leads to a loss of potentially recoverable resources.

4. From Waste Management to Resource Management

4.1 Moving towards Recycling

Ideally we should have a situation where all metal and mineral resources are fully recycled and where all other materials are fully biodegradable. In that case landfill and incineration of waste will be avoided. However, this scenario does not say anything about the amount of resources we are using and the proportion of resources that has to be recycled (i.e. waste per capita).

Principally processes of waste management can be classified into the categories: landfill (disposal), incineration (thermal recovery) and recycling (including composting/digestion). When plotting the data of individual countries in a Venn/triangle diagram (Figure) the position of different countries in terms of waste management becomes apparent. In most cases the initial position is the right corner which means that 100 % of waste ends up in landfill or dumps. The final goal is to reach the left hand corner, where 100 % of the waste is recycled and incineration as well as landfill is completely avoided. As an intermediate target incineration can be found in the top corner. Commonly the evolution in waste management follows the direction indicated by the pink arrow, moving away from the landfill corner towards the edge between incineration and recycling (i.e. landfill: 0 %). However, in order to reach the left corner (100% recycling) it would be necessary to follow the green arrow, meaning that incineration has to be substituted by recycling.

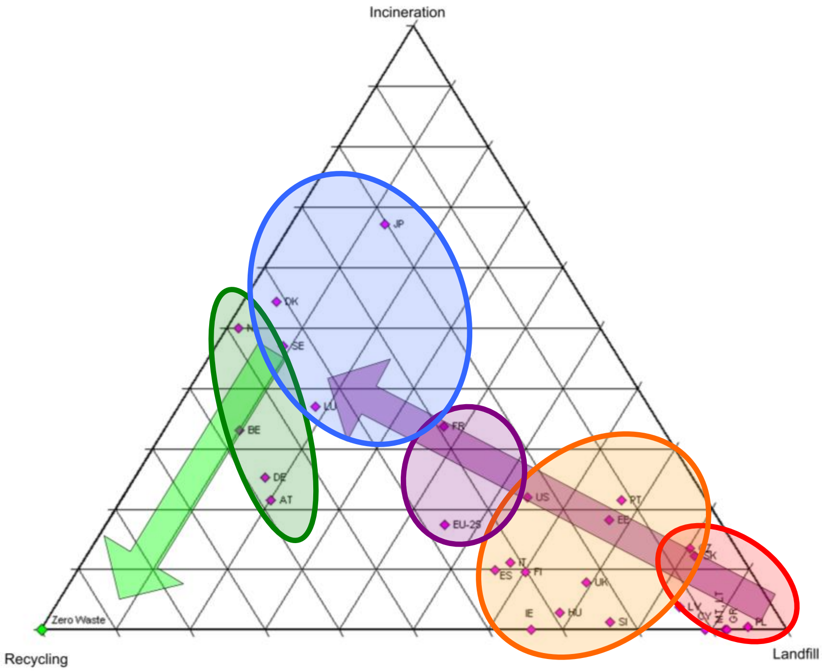


Figure 6 Evolution of waste management towards Recycling.

Individual countries can be categorized into five groups (Figure 6 and Table 1). The "red" category contains countries that still have a very large potential to improve their waste management strategy. They depend heavily on landfill (> 80%). The next group ("orange") has already achieved advances in avoiding landfill. However, still more than 50 % of the waste ends up in landfills and thus, also these countries have much room for improvement.

In the region of a landfill rate between 20 and 50 % ("pink") the EU average can be found. The countries which are more advanced in waste management have a landfill rate below 20 %. These countries can be separated into two groups. On the one hand the "blue" group is characterized by a high portion of incineration and therefore exhibits a recycling rate below 45 %. On the other hand the "dark green" group exceeds a recycling rate of 45 %, thus, representing the top class in waste management. However, also the "dark green" group has still a considerable far distance to the final goal.

Group	Description
Red	Landfill: > 80 %; large room for improvement
Orange	Landfill: 50 – 80 %; already considerable advances achieved; further improvement necessary
Pink	Landfill: 20 – 50 %; European average
Blue	Landfill: < 20 %; recycling: < 45 %; far advanced in avoiding landfill; potential to increase recycling
Dark green	Landfill: < 20 %; recycling: > 45 %; corresponds to current state-of-art
Light green	Optimal waste management

Table 1 Advances in terms of moving towards recycling.

4.2 Moving towards Resource Management

In order to ensure the availability of resources in the future and to counteract the steady increase in global demand for primary resources as well as to reduce the negative societal impacts associated with meeting this demand it is necessary to manage natural resources through:

- optimizing material use and material recoverability in the life cycle of products
- decreasing material use in consumption
- widely and effectively improving the collection and recovery of materials

This is a next step in the evolution of waste management where waste management and waste prevention form the basis of resource management.

It is necessary to optimize the chain of actors and processes from material extraction to final use. Especially the stages of design and manufacturing are crucial steps in the resource lifetime of a product and strongly determine the possibilities for later reuse and recycling. It is in these phases that decisions are made about materials and components and their interconnections. The possibilities for later reuse and recycling of the different components and materials are dependent on those decisions. When optimizing resource use it is therefore crucial that in these stages the importance of reuse and recycling is fully recognized and products are designed and produced to facilitate this. This means that waste managers, retailers, producers and suppliers will have to work together in a joint effort to find the optimal solution for resource recovery. When this situation is reached waste management will have become resource management.

4.3 Instruments to drive waste prevention, waste minimization and resource management

- Introduce or enhance recycling schemes

  The first step in turning waste into a resource is by setting up effective schemes for separate collection and recycling. Most common schemes for separate collection are those for organic waste, paper and cardboard, metals, plastics, electric and electronic equipment, batteries and hazardous waste.

  Effective collection schemes are designed to fit the specific local and cultural circumstances. Generally speaking collection schemes based on door-to-door curbside collection are more effective in ensuring higher collection rates than collection schemes based on bring facilities, such as street-containers. Collection through retailers can also be very effective, especially for those waste items that occur irregularly in a normal household, which are too small, or are too hazardous to design a separate collection for, such as: medicines, batteries, energy-saving lamps and small electrical appliances.

  An important part of a collection scheme is communication. Not only the technical communication on where and how is important, but more important is the why. Raising awareness and commitment is essential in a successful recycling scheme. This also means that communication at the introduction of a recycling scheme will not suffice, but that it has to be a continuous effort.

- Introduce financial stimuli

  The introduction of financial stimuli on a household level usually leads to significant reductions in the amount of residual waste and an increase in the amount of recovered materials. The development of the amount of residual waste versus material recovery in Flanders and the Netherlands, for instance, clearly illustrates this, as can be seen in figure 7.

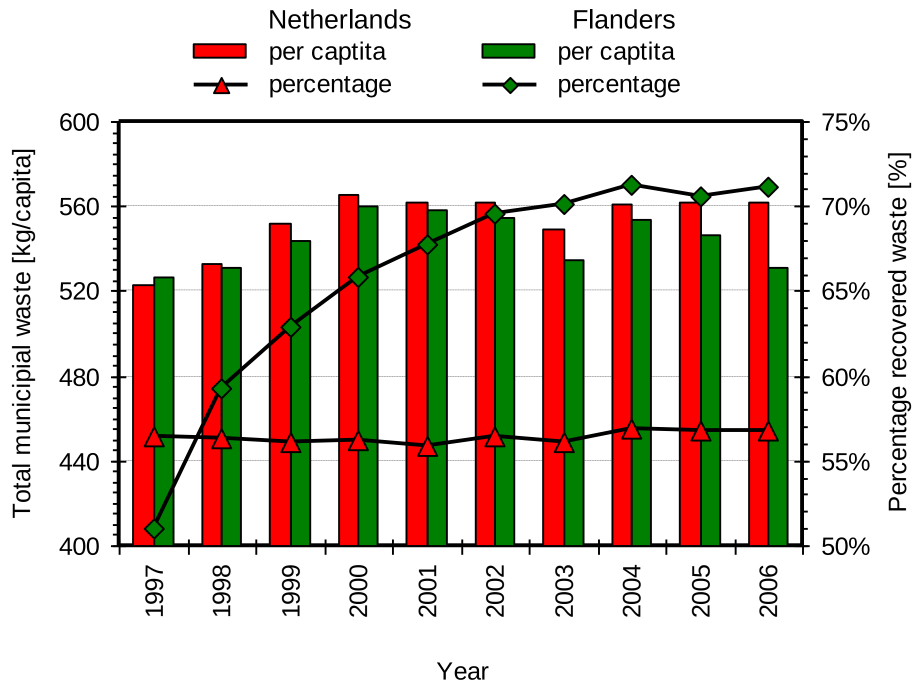


Figure 7 Effect of "Pay-as-you-throw" scheme.

The total amount of household waste in both countries is more or less the same. In Flanders pay-as-you-throw schemes have been introduced on a very large scale which has lead to a divergence between the amount of residual waste and recovered materials. In the Netherlands where these systems had not been introduced on such a large scale, a divergence between the amount of residual waste and recovered materials is still not visible. Also in other counties pay-as-you-throw schemes have proven to be a very effective instrument to reduce the amount of residual waste and to improve the amount of source separation.

Another way of introducing financial stimuli is through deposit return systems. In many countries world-wide deposit return systems are applied for the collection and recycling of beverage packaging. These kinds of system have proven to be very effective with a collection rate that can be as high as over 95%. No other collection system can bring these kinds of results. Deposit-return systems also lead to a high purity of the collected material which enables high quality re-use and recycling.

Green taxation has proven to be a potentially strong financial instrument. Many countries have introduced taxes on landfilling and/or incineration. Especially in those cases where the gate-fees for waste treatment are lower than the cost for separate collection and recycling, a landfill or incineration tax can be very effective and make separate collection and recycling economically viable.

There are, however, many more applications of green taxation that could drive sustainable production and consumption. Since taxation regimes differ between nations, the possibilities for green taxation will also differ. In general, however, green taxation works well when it leads to perceived financial benefits in the consumption of sustainable products or services compared to other products or services.

- Extended Producer Responsibility

According to the OECD Extended Producer Responsibility is a concept whereby manufacturers and importers of products bear a significant degree of responsibility for the environmental impacts of their products throughout the product life-cycle. Producers accept their responsibility when designing their products to minimise life-cycle environmental impacts, and then accepting legal, physical or economical responsibility for environmental impacts that cannot be eliminated by design. European legislation has applied this principle to different waste streams such as electric and electronic waste (WEEE), end of life vehicles (ELV), packaging, and batteries and accumulators. In some countries other examples of producer responsibility can also be found, for instance for hazardous waste, textile or window panes.

The goals of producer responsibility are usually threefold:

- To stimulate eco-design
- To enhance separate collection and recycling
- To include the environmental cost of end of life recovery in the product price (polluter pays principle)

The impact on waste minimisation of an EPR approach is clear as we can notice how environmental performance of products subject to EPR law has improved, particularly regarding hazardous materials reduction and improved recyclability and recycling as shown in figure 8.

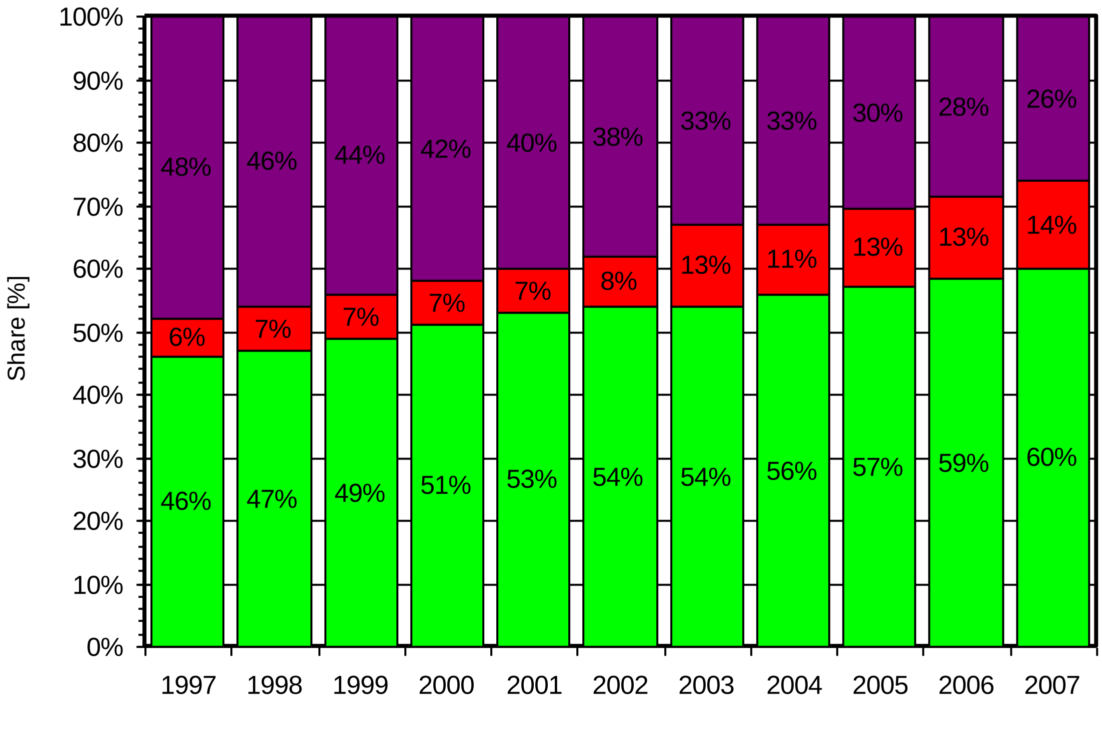


Figure 8: Treatment of Packaging waste 1997 – 2007 (Source: EEA)

In both cases legislation based on EPR principle has been a fundamental driver to recyclability and to effective recycling in Europe.

Experience with extended producer responsibility around the world shows that EPR can be very effective in enhancing separate collection and recycling.

- Green Public Procurement

  Public authorities are major consumers. By using their purchasing power to choose environmentally friendly goods, services and works, they can make an important contribution to sustainable consumption and production. Although green public procurement (GPP) is a voluntary instrument it can play a key role in the efforts to become more resource-efficient. It can help stimulate a critical mass of demand for more sustainable goods and services which otherwise would be difficult to get on to the market. GPP is therefore a strong stimulus for eco-innovation. To be a success GPP needs clear and verifiable environmental criteria for products and services. A number of countries already have national criteria, and the challenge now, as GPP becomes more widespread, is to ensure that these criteria are compatible between countries. A GPP level playing field will boost the international market.

- Research and Development policy

  To realise resource efficiency, research and development is particularly relevant not only to make the existing products and processes more efficient but also, more fundamentally, to innovate new ways of delivering products and services in a less resource-consuming manner. Business may drive the development of new products and processes but many of the key innovations have their origin in publicly funded research. Governments should therefore support R&D activities whose initial financial return may be uncertain or low but through which the long-term public benefits are potentially significant. Governments can do this through a coherent 'R&D policy' to foster domestic R&D activities needed to build a comprehensive national scientific and technological capacity on resource efficiency.

- Integration of waste prevention in environmental permitting of SME

  Small and medium sized enterprises (SME) usually operate with an environmental permit or within generic environmental framework conditions. Waste prevention and recycling can be made part of these regulations.

  Waste prevention and recycling options can be taken into account in each phase of the permit procedure. In the application phase it is essential to collect all information needed. Before the permit-granting authority issues a decision, it can discuss the possibilities for preventing and recycling of waste. The permit decision may include conditions dealing with waste prevention and recycling.

- Integration of environmental criteria in product regulation

  When the concept of extended producer responsibility was introduced the expectation was that producers would have a natural interest in making better products which would contain less hazardous substances and which would be easier to recycle. To a large extend this has not occurred, mainly due to the fact that the management systems producers have set up do not discriminate between “good” and “bad” products.

  The next step in environmental legislation will therefore be to incorporate environmental requirements into product legislation. These requirements may involve the banning of certain substances in products, requirements for energy consumption, requirements for traceability and recyclability of products, components and materials, and criteria for the use of materials in certain applications.

Integration of environmental requirements in product legislation is feasible for developed and proven standards and technologies.

- Product Service Systems

  A product service system (PSS) is a system where the ownership of a product is replaced by the utilization of a service. The service can take many forms, from leasing a car, to a delivery laundrette, a digital (web) service or lighting as a service.

  A PSS aims to satisfy consumer needs and at the same time reduce the consumption of products and / or to utilize products more efficiently. Because in a PSS the consumer is not the owner of a product, the products involved in delivering the service return to the service provider or the producer. This reduces waste on the consumer side and gives far more possibilities for product or component re-use as well as for dedicated recycling solutions on the side of the service provider or producer. For consumers the use of a PSS can have the benefit of regular technological updates.

  A shift from an economy based on production and consumption of physical products to a service based economy is needed in order to counteract the effects of increased consumption caused by the growing population and its growing economical capacities to fulfil consumer needs through consumption.

- Sustainable design

  To reach a situation where products are produced and consumed in a sustainable way it is necessary to change the way products are produced and consumed. To be able to do this we will need criteria for the evaluation of the sustainability of different types of goods, products and services. Since the range of products, goods and services involved is very broad and may differ from a plastic shopping bag to a car, it is meaningful to make a distinction between different types of goods and products.

  Figure 9 illustrates the design, production and consumption criteria for different types of goods. A distinction is made between durable and non-durable goods and between goods with a low value and complexity and goods with high value and complexity. In general non-durable goods should preferably be made biodegradable or fully recyclable. The environmental impact of the production phase of non-durable goods is often bigger than the impact of the use phase; therefore the production process itself is important.

	Non-durable goods	**Durable goods**
High Value and Complexity	Lifestyle Products	Durable Consumption Goods
	Focus on: • Biodegradability • Production process • Re-use	Focus on: • Reverse logistics • Re-use • Product service systems • Energy consumption • Ability to disassemble
Low Value and Complexity	Fast Moving Consumer Goods	Other durable Goods
	Focus on: • Biodegradability • Production process • Minimize transport • Recyclable packaging • Separate collection	Focus on: • Minimize material use • Singular material use • Recyclable packaging • Separate collection • Minimize transport

Figure 9 Design, production and consumption choices to be made for different types of goods.

5. Conclusions

It is clear that waste management has made tremendous developments over the last decades. The challenges that we have to face today, however, also make clear that traditional waste management is not sufficient to deal with the issues related to waste prevention, sustainable production and consumption, and with resource management.

In order to ensure the availability of resources in the future and to counteract the steady increase in global demand for primary resources as well as to reduce the negative societal impacts associated with meeting this demand it is necessary to manage natural resources through optimizing material use and material recoverability in the life cycle of products, decreasing material use in consumption and the wide and effective collection and recycling of materials.

To tackle these issues a mind shift is needed. It is necessary to act on many levels and with many partners. A large set of instruments and policies is available to trigger this development. The question is not which instruments we should apply, but how we can apply and combine the available instruments in order to achieve the best results.

Drafted by ISWA Working Group Recycling and Waste Minimization, 2011.
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Adopted by ISWA Board, 2011.