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Bavarian Institute of Applied Environmental Research and Technology

TRANSFER OF NATIONAL EXPERIENCES WITH WASTE PREVENTION AND MINIMISATION TO A TRANS-REGIONAL OR AN INTERNATIONAL LEVEL

- SCOPING PAPER -

Study for

UNEP

Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit

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List of abbreviations

APO	Asian Productivity Organisation
BAT	Best available technique
BCSD	Business Council for Sustainable Development
CP	Cleaner Production
DSD	Green Dot System, Germany
EEA	European Environment Agency
EEB	European Environmental Bureau
EEC	European Economic Community
e.g.	exempli gratia (Lat.), for example
EMAS	European Eco-Management and Audit Scheme
EnTA	Environmental Technology Assessment
EPA	Environmental Protection Agency, USA
EPR	Extended Producer Responsibility
ESM	Environmentally Sound Management
ETCWMF	European Topic Centre on Waste Material Flows
EU	European Union
GDP	Gross Domestic Product
GNP	Gross National Product
GP	Green Production
i.e.	id est (Lat.), that is
IE	Industrial Ecology
IPP	Integrated Product Policy
IPPC	Integrated Pollution Prevention and Control
ISO	International Standards Organisation
LCA	Life Cycle Analysis
MFA	Material Flow Analysis
MIPS	Material Input per Service Unit
NCPC	National Cleaner Production Centres
NGO	Non governmental organisation
OECD	Organisation for Economic Co-operation and Development
p.	Page
pp.	Pages
P2	Pollution Prevention
PET	Polyethylene terephthalate
PAYT	Pay As You Throw
PRN	Packaging Recovery Notes
UNEP	United Nations Environment Programme
UNEP IE	United Nations Environment Programme Industry and Environment
UNEP DTIE	United Nations Environment Programme, Division of Technology, Industry and Environment
UNIDO	United Nations Industrial Development Organisation
USAID	United States Agency for International Development

Executive Summary

A Preliminary remarks

Waste quantities in most countries are growing faster than private consumption does, so that waste generation per Euro spent by households is increasing. Growing waste amounts generally postulate an enhancement of waste prevention and minimisation. Also the recycling of waste rises. For example the recycling of paper in EU Member States has increased from 35 % in 1985 to 49 % in 1996. But at the same time, however, the total quantity of paper incinerated or disposed on a landfill has also increased due to the growth in consumption of paper and cardboard.

The concept of waste prevention is not entirely new nor is the practice. In the chemical industry this idea goes back 100 years when prevention was called “yield improvement” e.g. making more products with the same amount of raw material.

For an effective implementation of waste prevention and minimisation it should be envisaged to use the experiences of different regions or countries. Thus the know-how, skills, processes and technologies should be transferred from one country or region of the world to another if appropriate. The prerequisites for a transfer are the uniformity of terminology, information about concepts and instruments as well as knowledge about the role of important groups and differences. Moreover, measures to be transferred need to be evaluated by corresponding indicators. This scoping paper “Transfer of national experiences with waste prevention and minimisation to a trans-regional or an international level” generally addresses these issues.

B Terminology

When regarding the terminology in the area of waste prevention and minimisation different terms are commonly used and a strict global definition of single terms does often not exist. Besides the necessity to use the same terminology the waste hierarchy, i.e. which kind of action, treatment or measure is favoured in each country is important to be considered.

The definition of waste is normally regulated in corresponding laws. But due to certain ambiguity of the waste legislation, the European Court of Justice has been called upon to resolve a number of disputes, to interpret the waste definition.

Waste Prevention

According to Figure 2-1 waste prevention comprises the strict avoidance, the reduction at source and the product re-use. Waste prevention comprises activities that reduce the quantity, the hazard and/or the energy content of materials before they become waste. In general, it is more difficult to implement these types of activities and to measure their results than more traditional waste management activities.

Waste Minimisation

As shown in Figure 2-1 waste minimisation is broadly understood as measures or techniques preventing and/or reducing the generation of waste by improving the quality of waste generated, such as reducing the hazard, and encouraging recycling and recovery to reduce the volume of waste landfilled. Hence, waste minimisation includes waste prevention.

A point of discussion is the incineration of waste which is considered as waste minimisation regardless if with or without energy recovery in some countries, e.g. Japan, but is excluded from waste minimisation in other countries.

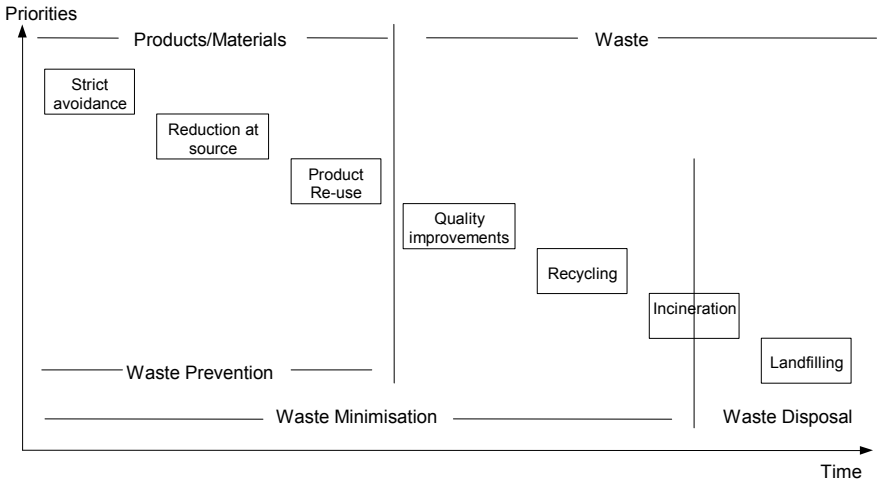


Figure 1-1: Terms used in waste terminology [modified after OECD 1998a and OECD 2000]

Waste Recycling

Waste recycling generally means any process by which waste materials are processed and returned to the economic mainstream in the form of raw materials or products to be manufactured in the same or a similar product. It is essential to clarify in detail which activities are covered under the term “recycling” by different countries and in which hierarchy the activities are applied e.g. if the use as fuel substitute or for energy recovery is included or not.

Zero Emission

Generally, the term Zero Emission has two different meanings:

The concept promoted originally by the United Nations University in 1994 is an integrated system in which all industrial inputs are used in final products or are converted into value-added inputs for other industries or processes. This definition is used, for instance in Japan.

Zero Emission defined by ICT/IKP/PE[1] is not the demand for processes converting the complete material because this would scientifically and technically not be practicable. In fact, Zero Emission is an integrated concept for the future including the protection of the environment, saving natural resources, securing economic interests, providing employment and educating the youth.

[1] ICT: Frauenhofer Institute for Chemical Technology, IKP: Institute for Plastic Examination and Science, PE: Product Engineering GmbH

Household Waste / Municipal Waste

Household waste is solid waste, which usually originates in the residential environment. Waste with similar characteristics generated in commercial activities, official buildings like schools or governments, etc. can be treated and disposed of together with household waste. Municipal waste is household-type waste collected by or on behalf of municipalities and household-type waste collected by the private sector. Because municipal activities can vary from one region or country to another different waste streams are called municipal waste. Therefore, data and information on municipal waste must be expected to be incomparable.

Effects of different regulations

The fact that there is no or little legislation about waste prevention and minimisation in most developing countries or countries with economies in transition causes the following problems:

Binding laws in waste management oblige the respective countries and industrial sectors to take measures to prevent or minimise waste. Countries like Cameroon or China, which don't have binding laws in this sector, may realise the necessity of the conservation of nature and human health, but probably their industries and population are not willing to voluntarily implement technologies or change their behaviour.

Furthermore, the absence of a consistent terminology can be a problem as a result of missing legislation. A legal system gives the scope for the transfer of know-how or technology. The lack of a legal system in the waste management is responsible for the absence of a control system to assure the efficiency of a technology also after its implementation. Due to different specifications in waste legislation the waste hierarchy of different actions, treatment or measures favoured in each country can be different. If there are no regulations there are no limits to contravene with the implementation of new technologies.

Conclusion

Predominantly, there are similar general understandings of waste prevention and waste minimisation. One point of discussion is the classification of the incineration of waste. It should also be clarified which kind of treatments are really considered within recycling. Also the waste categories should be similar for uniform data collection. The European juridical disputes about the waste definition illustrate that the problems of terminology originate in the detailed interpretation of common terms. In addition, it is not sufficient to use just the same definition but the practical realisation has to correspond, too.

C Concepts of waste prevention and minimisation

As there are a lot of different concepts, strategies and programmes aiming at least partially at waste prevention or minimisation the list presented here is an extract of the most important issues. In a first step basic principles are explained:

Polluter Pays Principle says that waste producers have to bear the costs for environmentally sound disposal of their waste. It allocates social costs of environmental impacts to the responsible causers and thus prompt them to take these costs into their price calculation. This cost allocation is an incentive for waste prevention and minimisation.

Precautionary Principle includes not only an averting of imminent danger but also detecting and preventing environmental impacts on an early stage. The Precautionary Principle aims at the protection of natural resources in the long-term and thus represents an important element of a sustainable development.

Cooperation Principle: In case of important environmental affairs, concerned and interested social groups should participate in the preliminary decision process. By this means a high degree of experience and know-how shall be achieved as well as existing clash of interests shall be reduced in advance.

In the following an extract of concepts, strategies and programmes is briefly described:

Integrated Pollution Prevention and Control (IPPC) focuses on the shift from media-specific to integrated permitting. As example it is increasingly applied in the European Union. Since 1996 the IPPC Directive focuses on an integrated permitting of industrial installations to control environmental emissions, for all environmental media, rather than on regulating individual media problems. Perhaps the most important feature of the IPPC approach is that the emission standards are based on best available techniques (BAT). BAT bulletins will be elaborated as assistance for the licensing authorities.

Extended Producer Responsibility (EPR) / Product Stewardship: This means that the manufacturer is responsible for various aspects of the product's life cycle, beyond just the manufacturing stage. EPR aims to achieve environmental improvements throughout the life cycle of a product. The basic principle is to extend the responsibilities of the manufacturer not only to the way of production of goods or what performance standards they meet but also to take-back, recycle and finally dispose of goods.

Integrated Product Policy (IPP): Due to several activities in different countries a variety of interpretations of the term IPP exists. The global objective of IPP is to continually optimise products and related services to reduce their impacts on the environment or humans during all phases of a product's life-cycle by taking action where it is most effective. The life cycle perspective involves many actors as designers, industry, marketing, retailers, consumers and disposal services.

Cleaner Production(CP)/ Clean Technology/ Pollution Prevention(P2)/Green Production (GP) have the same overall aim but in detail they can be different. These concepts stand for a strategy to continuously improve processes, products and services by technical, organisational and educational measures to increase efficiency and reduce risks for humans and environment. They include waste reduction by reducing or eliminating pollutants by increased efficiency of raw materials, energy, water and land. These terms are opposed to end-of-pipe technology because the environmental equipment is integrated into the production process. They are not only an environmental strategy but include also economic considerations.

Strategic Waste Prevention is a long-term policy concept within a resource management and sustainable development perspective. Strategic Waste Prevention works toward the reduction of absolute waste amounts, hazards and risks, and is characterised by at least four aspects: a life-cycle perspective, a material-differentiated approach, integration of social and economic aspects into environmental policy discussions, and facilitating co-operation across traditional institutional structures for overall policy synergy. This strategy is multi-faceted, having links to and being driven by the application of other evolving concepts such as Eco-Efficiency, IE, IPPC, EPR and IPP.

Eco-Efficiency was established in 1992 by the Business Council for Sustainable Development. It is achieved by 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. The short definition which is generally accepted is: creating more value with less ecological impact and less resources. That means the combination of economic and ecologic efficiency.

Industrial Ecology (IE) is a concept for new patterns of industrial production and is closely related to the Cleaner Production concept.

ISO 14001 /EMAS: ISO 14001 is an international norm for an environmental management system. EMAS is the European version of it (European Eco-Management and Audit Scheme). With ISO 14001 and EMAS companies and other organisations introduce and enhance a management system which allows to measure, report and improve their environmental impacts.

Environmental Technology Assessment (EnTA) focuses on identifying and evaluating both specific and broader environmental impacts generated by a technology. It examines the wider technological process over its entire life cycle and then determines the likely implications for the environment.

Material Flow Analysis (MFA): Analysing material flows aims at evaluating the fate of materials. Materials can be specific compounds, or individual resources. Material flow accounting refers to the analysis of materials throughout the entire cycle of economic activity. MFA is suggested as an accounting tool to monitor waste and measure material flows, in order to establish quantitative basis for measuring pollution prevention.

Ecological Associations and Initiatives: There is a variety of possible associations and initiatives to improve environmental impacts in general. Partners for these initiatives can be companies, local or regional governments or authorities, businesses, institutes, and universities. The aim is to promote and support environmentally sound operations and to use synergies among the partners. Within these initiatives discussions about waste prevention or minimisation problems can lead to implementations or development of regional programmes or pilot activities.

Re-use: Products and items can be re-used on different levels. At the first level there is the multiple use of the original product for its original purpose. Then the original product can be used for an alternative purpose with or without reconditioning. If the product is broken it should be repaired and if the owner doesn’t want to use the item anymore it can be sold. Both, industries and consumers are demanded to support re-using products.

Life Time Prolongation of a product or an item retards the production of a new product. The prolongation can either be achieved by better maintenance of the product or by an improved design for more durable products or components. Life time prolongation can contradict innovation and contradicts the present trend of the consumer society which favours short-lived products such as mobile phones or other fashion products. Promoting Life Time Prolongation generally is not adequate because the prolongation needs not always to be environmentally sound. Thus, an examination about the impacts should be done.

Recycling: In many countries there are a lot of different activities and technologies for the recycling of waste. Recycling facilities are usually subject to licensing procedures but there

are not always binding technical standards respectively standards vary considerably which leads to different prices. Thus, waste may be transported to the cheapest treatment place which results in low-quality secondary material. Recycling is always some kind of a down-cycling meaning that parts of the valuable resources are transferred in less valuable items. Complete closed loops are not possible due to physical and economical reasons. Recycling is more efficient the more genuine the material is. Therefore, selected waste collection is an advantage as well as mono-structured components of products. To know whether recycling is reasonable for a specific waste stream, product or material, it is essential to evaluate the net ecological impact of these activities.

Pay As You Throw (PAYT) is a system for municipal waste in which the waste producer pays for the collection and disposal of its waste proportionally to the amount of waste generated. That means that the fees are calculated per weight and no longer per capita, household or container. This gives an incentive for the polluter to reduce its waste.

Transfer – concepts, aspects and demonstration projects: Some of the above described concepts are quite complex. Especially in developing countries or in countries with economies in transition there might be an implementation problem represented by knowledge deficiencies. For promoting and facilitating the implementation of these concepts the communication and qualification of the people appears to be a prerequisite. To overcome this problem a consultancy process can be introduced. The basic idea is that the consultants provide the necessary information and tools as relevant background for decision makers and train these.

Demonstration or pilot projects as well as case studies are useful and necessary to start a dynamic process especially in developing countries and in countries with economies in transition. The projects can be manifold i.e. deal either with an improvement of organisational, industrial or administrative structures or technical equipment can be realised. When these kinds of projects are successful they are a good example for the expenditure of the respective structures or equipments in further projects.

Life Cycle Assessment (LCA)

Several of the concepts, strategies and programmes mentioned above include the life cycle approach. This emphasises the importance of thinking in life cycles. A Life Cycle Assessment is a technique for compilation and evaluation of the inputs and outputs, and thus the potential environmental impacts associated with products, processes or services throughout their life cycles. This cradle-to-grave analysis begins at the extraction of resources, through production of materials and products over the use of products, processes or services up to discarding, reusing or disposing. The environmental burden covers impacts upon the environment, including extraction of resources, emissions into air, water and soil. The cradle-to-grave approach is important so that there is no generation of a “problem shifting” that means that one environmental problem is not solved by shifting it to another stage in the products life time or to another media. For instance manufacturing a car out of aluminium instead of steel means that its gasoline consumption is reduced but the production of aluminium requires more energy than that of steel. Only if all these facts are taken into account it can be judged whether a car made of aluminium is truly more environmentally friendly than one made of steel. LCAs are most often comparative studies to compare different products, processes or services concerning their function. For a standardisation of the performance of a LCA study a methodological framework, ISO 14040, was established by the International Standards Organisation (ISO).

The main applications of LCA are:

- Identification of the origins of environmental impacts
- Identification of improvement variants of a given product, process or service
- Information for selecting between a number of products with the same function
- Assistance in decision making in industry, governmental or non-governmental organisations (strategic planning, priority setting, product or process design)

In LCA individual waste treatment processes can be analysed such as packaging beverages, Green Dot System, recycling of used oils, sewage sludge, biological wastes. Or LCA analyse whole waste management systems to generally evaluate which waste treatment has the biggest overall impact on the environment. In Germany several LCAs have been conducted to clarify waste economic and management questions.

The LCA methodology helps to chose the most efficient ranking and selection of waste minimisation tools. The disadvantage of LCA is that it is a quite expensive instrument due to the high complexity of such analyses which need time to be conducted.

Conclusion

There is still some discussion amongst theoreticians concerning the differences and similarities between the concepts and strategies. However, from the point of view of practical implementation, the differences between them are small, with most of the concepts sharing a common emphasis on: no more end-of-pipe solution but life cycle approaches, simultaneous achievement of economic and environmental benefits, minimisation of risks to human health and environment and the sustainable use of natural resources.

The concepts and strategies differ in the significance of waste prevention or minimisation. Some of them focus on waste related issues such as Strategic Waste Prevention, Re-use, Life Cycle Prolongation, etc., others have a more general environmental background such as ISO 14001, or European examples such as IPPC or IPP. Another distinction is that many of the concepts basically apply at the company or organisational level (CP, ISO 14001, IE, IPPC, etc.), whereas PAYT, Re-use, IPP, etc., inherently engage multiple actors, including consumers. The different concepts or strategies complement each another.

D Instruments for waste prevention and minimisation activities

Especially for public goods such as clean air or water, the price mechanism of the market is not able to create an optimal allocation and usage of exhaustible resources. Thus, social and environmental costs of activities are not born by the corresponding economic player. Therefore, the **internalisation** of these costs - called external diseconomies - should be the major target of modern environmental policy, which shall affect economic players in a way that they take all costs (including social and environmental costs) of production respectively consumption into account. A policy which aims at waste prevention and minimisation can select measures out of a wide variety of instruments.

Mandatory instruments

They can affect waste holders´ decisions directly by administrative regulations. These measures are a common way to achieve environmental objectives since they assure a high ecological efficiency. Although regulations request that waste producers and holders must act in a predetermined way thorough control and monitoring is necessary. In this respect administrative shortfalls, possibly due to inadequate personnel resources in regulatory authorities, become a significant issue. Though regulations take effect very fast they are not appropriate to evoke technical innovations because of missing financial and administrative incentives, i.e. originators do not benefit from outperforming given regulations. Another important disadvantage is the lack of economical efficiency as every waste holder concerned has to adhere to commands. Differences between enterprises concerning their marginal costs of waste reduction are irrelevant for this kind of instruments.

Nevertheless, minimal **technical standards** for all waste recycling and recovery facilities are necessary in order to prevent the transportation of waste to cheaper plants, which often use lower level technologies. Low-quality recycling leads to the production of low-quality secondary materials, that are often more expensive than the virgin raw materials they could replace. As a matter of fact, these low-quality secondary materials are not competitive at the market. Thus, the harmonisation of technical standards is a good way to guarantee safe treatment respectively high-quality recovery of waste streams and thus the demand for secondary materials. Whereas **product standards** in form of input and output restrictions can help to reduce not only the total amount of waste but also its potential impacts on the environment. They influence the composition of the product by prohibiting the use of specific raw materials and supplies which have considerable negative environmental impacts during production, usage and/or disposal. Moreover, they can avoid the accumulation of harmful substances in goods in case of subsequent recycling activities. If voluntary environmental agreements have failed the threat of product restrictions may increase industries´ attendance to co-operate. **Product bans** can be seen as the last resort and should be used only when products are expected to cause high environmental damages.

According to the **Product Stewardship**, on the one hand, **take-back obligations** comprise the physical receipt of used products and thus the need for establishing adequate take-back systems and, on the other hand, they comprise the waste treatment and disposal by the institution that placed the product on the market. As companies face the fact that products once sold will be returned by customers, they are likely to consider future environmental impacts along the entire value chain, i.e. product development, production, distribution, consumption

and disposal and thus following the cradle-to-grave-principle. Manufacturers also have the best knowledge about the re-use and recycling options of their products.

When implementing take-back obligations some issues have to be looked at.

- Not every kind of product is appropriate to be dealt within take-back systems.
- High quantities of specific waste and/or waste with severe ecological impacts justify the usage of take-back obligations, for instance, used batteries, used electrical and electronic equipment, end-of-life vehicles, waste oil as well as expired pharmaceuticals. Moreover, take-back obligations are appropriate to be combined with deposit-refund schemes since they set an economic incentive for customers by increasing the value of the used product/waste by the amount of deposit.
- Deposit-refund schemes may help to reduce the littering problem. Finally, take-back obligations cause extra costs for producers/dealers since taking back, logistic, storage, disposal, documentation and verification management represent additional efforts.

New economical instruments that make use of the free market mechanism may help to achieve waste prevention and minimisation targets more cost efficiently.

Economic instruments

They do not prescribe when and how the waste originators have to act environmentally friendly. Instead, they assign incentives to award a change in behaviour. Principally based on the **Polluter Pays Principle** these instruments seek to induce economic players to design their goods ecologically friendly in order to reduce waste during production, usage and disposal. In order to cut their costs, originators are keen to reduce environmental pollution beyond the standard which is fixed by commands. In addition, economical efficiency on a high level is provided because originators can decide independently which measures they take. Thus, originators can act cost optimal according to the individual marginal costs of waste avoidance and a given environmental quality can be achieved with lower economic expenses. Financial incentives may foster innovations of environmental technologies as long as they exceed the marginal costs of avoidance. On the other hand, free market instruments are not always the best choice because their effects can be incalculable and/or temporally delayed (especially with ‘soft’ instruments like covenants). Particularly in case of severe environmental threats they do not seem to be as reliable and effective as administrative regulations. On account of this, new economical instruments should be implemented for precautionary measures rather than for defensive measures against immanent dangers.

Taxes on specific materials or energy increase their prices which leads to higher expenses for the companies purchasing. This can provide an incentive for the firms to reduce the usage of these specific resources and vary their input factors for the benefit of environmental sound ones. Moreover, the development of new and more effective technologies in production can help to enhance the resource productivity. Further, ecological taxes on products are applied if the production, utilisation and/or disposal of specific goods is connected with negative environmental impacts, for instance waste intensive products such as packaging. In both cases ecological taxes are intended to raise the prices for environmentally harmful in- and outputs in order to change the demand in support for environmentally sound products and processes.

While taxes, duties and fees punish originators of negative environmental impacts, **financial aid and economic incentives** shall award environmentally sound behaviour. Additional investment needs which are caused for example by increasing technical standards and restrictions can be supported by subsidies, low-interest credits, special depreciations, cost-free consultancy services and sureties. When implementing such support programmes special attention should be directed to the promotion of integrated technologies as they create processes which are really environmentally sound.

The system of **tradeable permits** describes the idea that the government stipulates a maximum amount of emission for a specific harmful substance in a well-defined area. If enterprises cannot avoid this pollutant they have to buy licences which certify the right to cause pollution equal to the purchased licence, whereby each licence represents a fraction of the total quantity permitted. In case of packaging waste licences certify the right to distribute a certain amount of non-reusable or ecologically disadvantageous packaging. In order to reach determined environmental objectives licence systems allow every polluter who is bound to buy licences a maximum of decision autonomy. If an enterprise utilises ecological resources that are controlled by licence systems it has to purchase the corresponding number of licences at the market. If it reduces its consumption the enterprise can sell licences which are not required any longer and thus finance its avoidance activities. For a company it is profitable to sell their licences when the selling price is higher than its marginal costs of reduction. In the long run the environmental agency has to keep the licence price high in order to foster technological progress. Innovative technologies could lead to a decline in demand for licences and thus to decreasing market prices that diminish the incentives to induce progress. Incentives usually remain if maximum limits are being tightened from time to time. These positive effects face configuration problems that have to be noticed in view of a successful implementation in practice.

Another approach to intensify the **self-interest of companies** in regard to waste prevention and minimisation could be an adequate design of the environmental liability. When producers originate environmental damages, according to the Polluter Pays Principle, they are responsible for the effects and have to bear all the costs. Hence, they should pay special attention not only to their production processes but also to their products if they want to prevent environmental risks and thus compensation payments.

More and more, **environmental protection agreements or covenants** complement or replace other environmental instruments like regulations, taxes or tradeable permits. Reasons are among other things the relatively high acceptability of companies concerned. They are free in their decision how to achieve the agreed environmental goals and thus they will choose a cost effective way. However, the enforcement of voluntary agreements is unsure when the imposition of sanctions is improbable respectively the sanctions are too weak. In this context, also the free-rider problem becomes inevitable. Hence, high costs for necessary monitoring and execution can over-compensate covenants´ advantages in respect of cost efficiency. Finally, the effort of covenants depends to a great extend on the flanking composition of financial incentives and legal measures.

Supportive instruments

In addition, there are various other instruments which can support waste prevention and minimisation efforts such as **environmental management systems**, **environmental education and information**, **environmental reporting**, and **eco-labelling**.

The mentioned instruments are used in many different combinations in different countries. Therefore, the comparison of countries in regard to the effectiveness of their environmental policy pursued is quite difficult. However, the most effective outcome is expected to be achieved by the combined application of means. An important basis for the successful implementation of these mandatory and economic instruments is the awareness of people. This is due to the fact that not only industry directly concerned by these instruments but also consumers and their behaviour decide about the result of the measures.

E The role of important groups

For an overall approach it is essential that all stakeholders come together, co-operate and find integral solutions.

Politics

The role of politics within waste prevention and minimisation is manifold. Many of the instruments previously described can be or have to be initiated and decided by politics. By the choice or the combination of different instruments **politics determine the scope of action** for stakeholders. As companies appreciate long-term specifications for reliable planning it is important that the country itself is stable concerning the political, cultural and economic aspects. Politics can also stimulate the co-operation on municipal, regional or national level by founding and supporting initiatives. With public investment being in line with waste prevention and minimisation politics can give a good example for other stakeholders.

In addition, politics should emphasise waste prevention and minimisation topics to raise public awareness and to initiate awareness programmes. An essential role of politics is also the implementation of international agreements into national laws. In this respect especially politics in developing countries and in countries with economies in transition should envisage to introduce regulations concerning waste management and waste prevention respectively minimisation. Further, politics should support the development of internationally comparable indicators and provide the necessary data.

In this context also the courts have to be mentioned since they are responsible for the interpretation of laws. Therefore, they create facts and defaults, for instance, in clarifying the precise definition of waste.

Industry

Companies and their associations are crucial in determining waste prevention or minimisation. They are important for the preparation of political decisions and for the implementation of measures. Industry uses their **lobby** in order to influence waste related legislation, the choice of instruments respectively their design. Their point of view is taken into account during legislative processes by inviting them to draft implementation plans or to comment on them. To avoid mandatory instruments or direct regulations with strict limits industry sometimes offers voluntary agreements.

For the **implementation** of waste prevention or minimisation measures industry can either fulfil only the necessary regulations given by law or they can achieve more waste prevention and minimisation by realising concepts previously mentioned. In the worst case, they can oppose regulations or voluntary agreements to gain competitive advantages.

Companies can actively support **research** to develop new environmentally sound technologies and they can **promote** products' re-use and repair by offering services for renting, leasing or repairing. Industry further has the possibility to promote actively a transfer of know-how and technology, advertise environmentally sound products, support public awareness campaigns or provide consultancy.

Public opinion

Public opinion affects the behaviour of consumers. Buying patterns, in turn, strongly influence the market system of supply and demand. Depending on the demand industry increases production.

Consumers and private households are requested to participate in separate collection or take-back systems. They have the choice to either support these activities or to boycott them. In addition, they can dump household waste illegally, reject user-pays programmes or continue to buy over-packaged goods.

Not only the media has an important influence on the public opinion but also politics can influence it by emphasising certain topics. These aspects can be used for essential awareness campaigns.

Social networks, organisations, initiatives, etc.

Each person is influenced by its ambience. This is the reason for the influence of the **family, clubs, parishes, cliques, neighbourhood and colleagues** on the attitude of individuals. Within these groups it is important that people give a good example in behaviour so that others can learn from them. Thus, individuals and communities can promote increased waste prevention by personal lifestyle changes. They can also be a source for information to persuade others. Mainly in cliques but also in neighbourhood or among colleagues group dynamics can be important. This means that individuals act like the group or corresponding to common rules and don't decide themselves.

The importance of **non-governmental organisations** (NGOs) in the international environmental co-operation has risen considerably in the last decades. NGOs took part in the development of waste minimisation policies in many countries. They have also an influence on public opinion. To achieve their aims they have created partnerships within different NGOs or with industries.

Several **international organisations** deal with the problem of waste prevention and minimisation in different programmes as UNEP DTIE, UNIDO, OECD. One of these activities are the National Cleaner Production Centres (NCPCs). Their role is to promote, co-ordinate and facilitate Cleaner Production activities. The purpose of the NCPCs is to build local capacity to implement Cleaner Production in developing countries and countries with economies in transition. NCPCs' aim primarily to transfer know-how and not just to transfer technology. The Centres and the trainers do not deliver ready-made solutions. They train and advise their clients on how to find the best solutions for their own specific problems. Therefore, they help to raise awareness, perform in-plant CP assessments and demonstration projects, train local experts, obtain financing for projects, exchange information and provide policy advice.

Universities and research institutes bear profound responsibilities to increase the awareness and knowledge, develop new technologies and tools to create an environmentally sustainable future. They could increase education, (applied) research, training, policy development and information exchange. In addition, universities and research institutes perform many co-operation projects with other national or international research institutes or companies. Therefore, they can be a motor for the transfer of know-how and technologies.

Financial institutions can steer waste prevention or minimisation with financing selected projects or giving loans. The award of financial means can be connected to special environmental requirements.

F The role of differences

Between important industrial sectors

The economy can principally be divided in **three sectors**: a primary sector generally including basic or extractive industries and farming, forestry and fishery, a secondary sector comprising processing industry and a tertiary sector covering services. At the beginning of an industrial development the primary sector is predominant, then the secondary sector achieves more importance and in a further development the tertiary sector grows. Extractive industries produce a high amount of residues with generally little danger. But hazardous residues can also arise depending on the extracted material e.g. for gold extraction. Services produce generally less waste with little danger than industries but this waste is often mixed and can arise at many places. This is a problem for collection and recycling. In processing industries all kinds of waste arise which is illustrated in the next paragraph.

In the construction industry great amounts of waste arise with low potential of danger. In this branch secondary raw materials from other industries can be used. In the chemical industry wastes with a high potential of hazard arise. In this industry also large uniform material flows can arise which can be returned into the process.

In branches with expensive raw materials higher financial incentives for reducing inputs respectively returning material flows into the process exist than in branches in which the price for raw materials are negligible.

There are also differences between large and medium sized enterprises since the large enterprises have higher capacities for caring about implementing concepts or strategies mentioned in chapter C. Differing from country to country not all industrial sectors are concerned by ordinances or voluntary agreements. Therefore, the willingness or the necessity to act is different. In addition, there are various specific recovery quotas and disposal requirements in divers regions and countries. Due to this aspect costs for waste treatment are different leading to specific burdens for the industry or to the transport of wastes to other regions.

Regarding local conditions in general

Local conditions vary significantly between different countries or regions due to the following factors:

If a country has a lot of **space** it is no problem to dispose of the waste on landfills. So there is no need to search for alternatives to either reduce the waste or treat it. Little space, mountainous topography or insufficient infrastructure can hinder logistics or the search suitable sites for landfills. In these cases it is more likely that methods for reducing or treating waste are developed.

The **climate** influences the stability and durability respectively the sensitivity of technologies or products. Before a technology is transferred it has to be analysed if it will properly function under the climatic conditions in other countries.

The **density and distribution of population** influence the logistic of waste collection and transportation. In rural areas it can be difficult and expensive to provide waste collection systems to every household since the distance can be far. When people live in cities it is easier to reach them by awareness campaigns. Overpopulation and growth of population deteriorate the waste situation so that the amount of waste grows exponentially. Then existing landfills or treatment plants can quickly be too small.

The **educational background** affects the creation of awareness for waste. If people have a low educational background they may be unconcerned about the waste difficulty and they may not be able to estimate or to know the impacts of waste. Awareness principally rises over the time during which the waste problem is recognised. Furthermore, people not well educated or not having experiences may not comprehend, analyse or overlook new technologies. In addition, different systems of education lead to different behaviour.

The **living standard** influences what is important for the individual. Poor people will not think about waste, in contrast, some of these people live from collecting valuable material from waste. If it is intended to reduce waste or recycle valuables one has to think about these people loosing their living basis. With rising living standard the amount of waste is increasing and therefore the necessity to act.

The attitude of people and their behaviour are also linked to the **type of government and to the economic system**. When responsibility, own initiatives and motivation are principally supported as it is the case in a democracy and free market economy, people will more easily think of problems concerned with waste. In addition, the political and economic systems influence the legal position, the possibility and the mix of instruments. The given legal background of a country is responsible for the impact of further instruments. Due to different legal backgrounds the environmental requirements are usually weaker in less developed countries.

Depending on the ideals of a **religion** it can support the awareness process for waste prevention and minimisation or it can hinder it. The hierarchical structure of a family, a company or a society depends on the socio-cultural background. Within a strong hierarchy people have much respect for the older people, patrons or directors. Thus, they will not oppose what is said by these people but will follow what they say without questioning it.

The **cultural background** of the participants strongly influences negotiations. For instance, Asians have a different way of discussing and finding solutions than Europeans or Americans. This has already to be considered in preliminary stages of negotiations.

G Maximum effect sectors

The maximum effect sectors cannot be determined worldwide because the maximum effect sectors can vary from country to country or region to region. In addition, maximum effect sectors can be determined in regard to the amount of waste, the hazard and the energy content of waste. History shows that actions or legislation processes usually start by handling or preventing hazardous waste. When these waste streams are controlled additional waste streams respectively sectors will be concerned. Especially in developing countries or in countries with economies in transition the maximum effect sectors can be totally different because they depend among other things on the industrial activity.

Priority waste streams defined by different organisations include mainly packaging waste, construction and demolition waste, industrial waste, end-of-life vehicles, waste of electrical and electronic equipment, used oil, waste tyres, used lead-acid batteries and pesticide waste. Quantitative relevant waste streams in the European Union are industrial wastes, mining wastes, construction and demolition wastes, municipal wastes, agriculture and forestry wastes. But these waste streams especially mining wastes, construction and demolition wastes are differing considerably from country to country depending on the industries active in the specific countries.

The potential of waste prevention or minimisation depends among other things on the present status of waste prevention and minimisation. In countries where a lot of efforts for waste prevention and minimisation have already been undertaken the potential is lower than in countries where no or only few measures have been implemented. Therefore, in similar structured countries the maximum effect sectors can also be different.

Maximum effect sectors generally depend on:

- Level of industrialisation
- Specification of industrial sectors
- Setting of objectives and level of achievement of objectives
- Complexity due to consideration of amount, hazard and energy content of materials or waste
- Nature of waste products, waste flows and waste materials.

These influencing factors emphasise that it is necessary to evaluate the maximum effect sectors in individual cases. A good method for such an evaluation is the value benefit analyses or the cost benefit analyses. Life Cycle Analyses or Material Flow Analyses are principally proper instruments to evaluate the impacts of sectors but these analyses are quite complex.

H Indicators for waste prevention and minimisation

For the evaluation and assessment of waste prevention and minimisation measures reliable factual information about waste and appropriate measurement tools are required. In this respect indicators play a significant role. Principally, indicators are used to elucidate impacts and changes of complex systems in a simplified manner. They can show both the environmental status as well as the reasons for that status.

Today a large number of **indicators** concerning waste generation and management is applied by national or regional governments and also by national or international organisations. Depending on the respective reporting, controlling or information purposes those indicators diversify as to their content, scope and their data sources. Most notably are the concepts developed by the OECD, the Commission on Sustainable Development of the United Nations, EUROSTAT and the European Environment Agency. As these indicators are influenced by diverse factors their interpretation is difficult. Unfortunately, the indicators and statistics are not based on really uniform definition of certain terms. Thus not even in the EU the data is comparable. Discrepancies, for instance, do exist among municipal waste. The data is inconsistent as municipal waste refers to management and collection concepts differing from region to region. In addition, the German Ordinance on Waste disposal, other than the respective European regulation, also considers sewage sludge and construction waste as being municipal waste. Hence, those definitions allow for a dissenting interpretation and consequently may lead to wrong conclusions.

The biggest **constraint** in respect to waste prevention indicators is the lack of available and comparable data. Quickly this becomes apparent whenever a comparative statistic on waste prevention issues is analysed, i.e. most of the indicator numbers are omitted or restricted in terms of their significance. Another crucial issue is the lack of specific methodology in developing and applying waste prevention indicators. Meaning cases where actually the same indicator is applied but the relevant data is recorded and compiled differently. Different dates and baseline years and the omission of unreported wastes are additional constraints. There is the lack of explanatory and defining guidelines as well as inconsistent definitions of waste across time and space. In addition, there is a lack of a legal mandate to undertake evaluations. Also, there is the lack of adequate financial resources for activities. And finally, without claiming a complete enumeration, there are constraints pertaining to the characteristics of waste prevention itself.

As the **complexity** of factors determining waste generation is high, it is difficult to establish indicators for waste prevention or minimisation. In addition, waste prevention comprises the reduction of amount, hazard or energy content. A reduction of one aspect can lead to the increase of the other. Thus, the amount of packaging can decrease by substituting glass for plastic but then the energy content increases. Therefore, it is not enough to regard only one aspect of prevention. Concerning the timing of waste prevention efforts must occur before products or materials are recognised as waste. Consequently these measurements try to evaluate what is not there. Thus data on waste prevention will hardly exist. In addition, similar waste prevention measures for products with different life time can show their impact with a time shift.

The lack of progress in developing specific waste prevention indicators can partly be explained by the complexity inherent in creating such metrics. Thus, there is a need to develop new or to amend existing indicators while paying attention to the following aspects:

- Need for uniform definitions of the indicator and its parameters
- Need for a uniform application of the respective definition
- Need for representative and consistent indicators dependent on the topics and addressees
- Need for a uniform data collection process
- Need for reliable and obtainable reference parameters
- Need for uniform reference years
- Need for a strong communication potential
- Need for long-term indicators

In addition, the differences mentioned in chapter F need to be taken into account when setting up comparable indicators.

Irrespective of all the theoretical and practical constraints regarding waste prevention indicators they serve their purpose as long as the constraints are noted and considered for interpretations. Indicators gain importance for policy makers when they will be comparable and appraisable on an international level. In this respect, benchmarking indicators could represent an approach to that problem.

I Previous failures and problems

Previous failures in achieving waste prevention and minimisation include lack of data, inadequate information, lack of system analysis and evaluation of results, lack of comprehensive cost-benefit approaches, lack of environmental sensitivity, lack of indicators, lack of “how to do” guidelines and inconsistent definitions of waste across time and space.

The **complexity** of factors determining waste generation is high. They include the intensity of industrial activities, demographic changes, technical innovations, way of living as well as production and consumer behaviour. This variety of factors is probably the most important reason for the insufficient success of the existing political strategies.

Constraints for implementation in industry are manifold. They can either be financial, economic, policy related, organisational, technical or conceptual.

A better **communication** between the single stakeholders should be envisaged to design products in regard to good recyclability. Also the promotion of environmentally sound technologies to spread merchantable technologies respectively help technologies to reach readiness for marketing should be improved. For the choice of the right measures individual analyses are necessary to assess the environmental impact e.g. for recycling activities as these can lead to a long-range distribution of pollutants and nutrients.

J Basel Convention and its possible role

As this scoping paper shows there is a need for harmonisation to enable consistent communication and perception of waste prevention and minimisation. A similar detailed terminology applied identically in different countries is the basis for further steps. Therefore, the first focus should be set upon a harmonisation of terminology. Harmonisation should also be envisaged in regard to guidelines and regulations. Laws should be simple, comprehensible and should give a long-term perspective. Technical standards should be regulated in frameworks corresponding to adequate limits for instance to ensure reliable quality of secondary material. Uniform indicators including consistent methods for data collection to ensure comparability have to be developed and agreed upon. Only with standardised long-term indicators reliable trends can be drawn up. Reliable trends are needed to evaluate applied instruments and their impacts. In all these aspects it is essential that the countries adopt the international regulations and act accordingly.

It is not advisable to implement the same instruments or concepts uniformly for all countries. There cannot be a single strategy for all countries. This is due to the differences in the regions or countries like legal background, climate, industrialisation, different kinds of industries, different maximum effect sectors. The different possibilities of concepts, strategies and instruments can generally be explained in guidelines and examples can be given which instrument is reasonable in which case or a methodology can be given how to find out the adequate instrument for a given problem. It is not adequate to principally claim recycling for every type of waste. To decide whether recycling of a given waste stream is the best alternative analyses considering all environmental impacts over the life cycle should be performed to evaluate the net ecological impact. Maximum effect sectors can differ strongly from one region or country to another so it is hard to identify such sectors generally. Nevertheless, priority waste streams should be pointed out and common targets should be set up and reached. These priority waste streams can differ from the maximum effect sectors in different countries. Methods to evaluate these sectors in single cases can be explained and exemplified in guidelines. Examples are value benefit analyses or cost benefit analyses, Life Cycle Analyses or Material Flow Analyses. One can conclude that in the approaches described above it is reasonable to give a frame and a guide for individual solutions and measures.

The Basel Convention should try to support the approach described above. With over 150 participating countries the Basel Convention is a good panel to assist the elaboration of consistent terminology, regulations and guidelines, technical standards and limits, indicators and targets. As other organisations also deal with the problem of waste prevention and minimisation the Basel Convention should try to co-operate with these organisations to create and use synergies. As the Basel Convention only has limited possibilities of enforceability respectively no penalty possibility it should be tried to convince the countries with factual argumentation. Therefore, it is essential to emphasise incentives and individual advantages for single countries to facilitate their participation.

An essential point when discussing terminology or regulations is that the Basel Convention takes into account that the individual countries might not have enough options to implement resolutions. The European Union, for instance, provides many directives and policies which have then to be implemented by the member countries. Thus, confederations of nations should be integrated into the decision finding process.

The Basel Convention already promotes Environmentally Sound Management which means taking all practical steps to minimise the generation of hazardous wastes and strictly controlling its storage, transport, treatment, reuse, recycling, recovery and final disposal. The purpose is to protect human health and the environment.

A promotion of waste prevention and minimisation could be i.e. as additional part integrated into the promotion of ESM. The promotion should be increased to raise the awareness for this topic. It should contain exemplary success stories from pilot projects, information on approaches to reach waste prevention and minimization including information on terms, possible concepts, instruments, etc.

There are already different activities and programmes on sustainability from various international organisations (UNIDO, UNEP DTIE, OECD, EU). It should be ensured that the activities linked with the subject of waste prevention and minimisation are networked and complement each other. At this point the Basel Convention could intensify its integration into these initiatives and co-operate with these institutions to use synergies instead of creating new concepts.

The NCPCs (National Cleaner Production Centres) and the Regional Training Centres (RTC) implement several of the points mentioned in this paper to support and facilitate the transfer of know-how and technology. If the examination of their success and efficiency is positive these activities should be enlarged. A good idea is that the NCPCs and the RTCs co-operate and work together to use synergies of their actions.

The Basel Convention has direct influence or contacts on the political level. Politics in the countries, in turn, are responsible to implement the agreements within the Basel Convention which then have impacts on industries and consumers. The only direct influence of the Basel Convention on locals exists over the Regional Centres. These should be used to introduce the idea of waste prevention and minimisation wherever possible for instance during the planning of new industrial plants. Thus, the Basel Convention can help to rise the awareness for waste prevention and minimisation.

As waste prevention and minimisation is a very complex subject and many different stakeholders are concerned it is necessary that they come together to raise the awareness and to find suitable solutions. Therefore, the Basel Convention should try to support initiatives or partnerships of NGOs, universities, institutions, companies, businesses and consumers.

K Proposed Action Plan

As long-term perspective for the improvement respectively the implementation of waste prevention and minimisation the following actions are recommended.

- As a first step it is essential to harmonise the terms and the corresponding definitions. A focal point should be the question if waste incineration is considered as waste minimisation or not and the question which waste treatments are included in recycling. In this regard, the Basel Convention could initiate the discussion in co-operation with other international organisations such as UNIDO, OECD, etc. to clarify and determine the terms and definitions.
- Second, from the technical point of view it is important to have general consistent standards e.g. for recycling facilities or best available techniques. The standards need to be regularly adapted to the technological progress in order to support innovation.
- Third, priority waste streams should be pointed out. Therefore, different basic conditions of various regions or countries have to be taken into account. Specific targets for these waste streams for different regions or countries should be set up and agreed upon. The specific targets should be met by each country after a predetermined period. The priority waste streams and possible targets could be elaborated in an additional study.
- Fourth, for these priority waste streams consistently defined indicators have to be developed and introduced as basis for the evaluation of measures and targets. Therefore, it is necessary that each country provides the corresponding data collected with the same methodology. In a further step, benchmarking of waste prevention indicators is an idea that qualifies for further research and development activities towards an improved and harmonised waste prevention system.
- Finally, it is not advisable to introduce the exactly same instruments or concepts uniformly in all countries. New instruments rather have to match and to be supportive to the existing structure of regulations and instruments. Further studies could analyse exemplarily which instruments are reasonable to be applied under certain given conditions.

Figure 1-2 illustrates the continuous loop of the above described steps. When the targets of the initial priority waste streams are achieved a new loop with additional waste streams or more ambitious targets will be initiated. Thus, the declining spiral expresses the increasing of waste prevention and minimisation.

In many aspects case-by-case decisions will be necessary to evaluate the net ecological impact of, for instance, waste treatment possibilities, because otherwise it is not possible to decide generally which waste treatment is reasonable. Only with a life cycle perspective considering basic conditions on site it is possible to identify the most environmentally sound treatment or action. This emphasises that it is not always reasonable to set up global regulations but to leave room for case-by-case decisions. Studies such as LCAs or value benefit analyses performed for specific waste streams can be the basis for decisions.

It is recommended to set up a working group to evaluate concrete suggestions and solutions for the above mentioned aspects. This group can be supported by additional independent studies about specific topics.

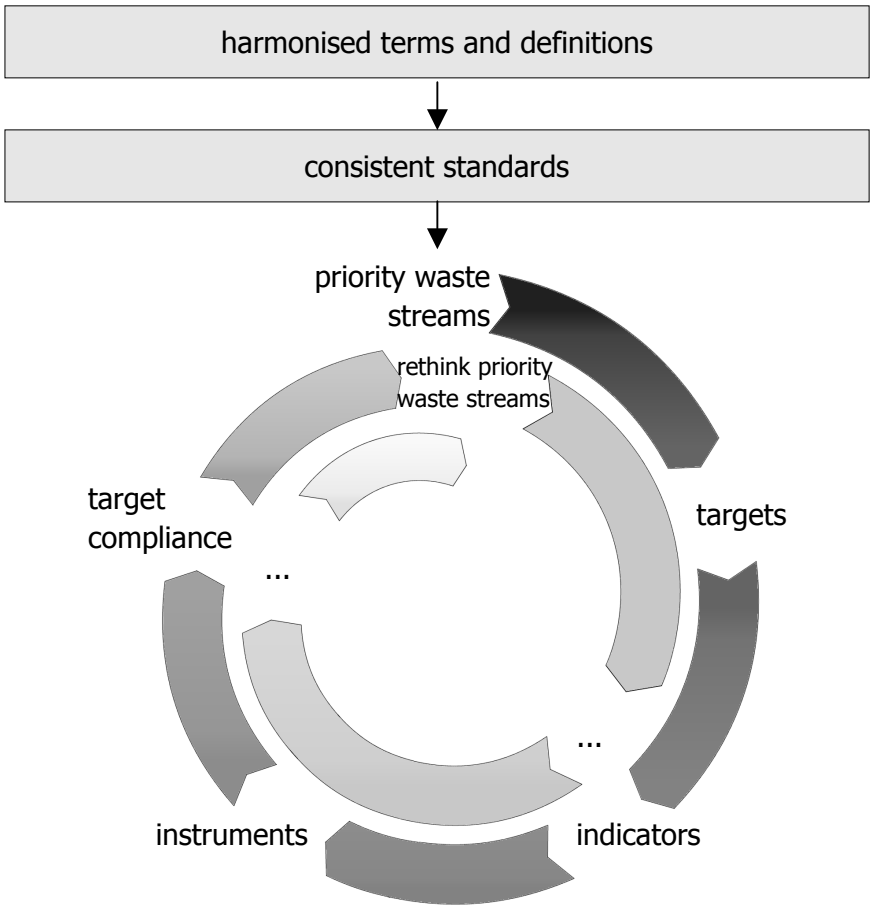


Figure 1-2: Waste prevention and minimisation loop

As the steps mentioned above are a global approach for harmonisation and enhancement of waste prevention and minimisation it will be difficult to implement it. It will take long time, a good financing as well as much effort before it will be implemented. To prevent inactivity in the meanwhile the following smaller actions are recommended as starting points which could be done by the Basel Secretariat:

- A guideline should be elaborated as practical aid for decision makers, politicians, enterprisers, consultants, administrators, etc. It should be a “how to do” guideline to help the practitioners to evaluate priority waste streams or maximum effect sectors for their region or country and elaborate the respective statistics, to select and implement proper instruments and concepts in regard to their individual circumstances concerning the aspects mentioned in chapter E and F The aim of such a guideline should be to give the practitioners tools to facilitate the individual approach for an enhanced waste prevention and minimisation. The tools could be, for instance, in form of a structured value-benefit analyses which exemplifies the advantages and disadvantages of instruments and give the criteria to evaluate a suitable ones. The elaboration of such a guideline could be a project within the Strategic Plan of the Basel Convention.

- Capacity building should be strengthened.
- Pilot projects with different topics and in different regions or countries can help to start a dynamic process in respect to waste prevention and minimisation. The topics can range from improvement of organisational, administrative or industrial structures over capacity building and consultation processes up to implementation of technological equipment.
- The Regional Centers are a good basis for an effective transfer of know-how and technology. They can support the exchange of experiences and consulting processes as well as capacity building. If the examination of their success and their efficiency is positive these activities should be enlarged. A good idea would be that these Regional Centers co-operate and work together with the National Cleaner Production Centers to use synergies of their actions.
- Promotion of waste prevention and minimisation in general should be increased to raise the awareness for this topic. This promotion should contain exemplary success stories from pilot projects, information on approaches to reach waste prevention and minimization including information on terms, possible concepts, instruments, etc. This part could either be integrated as additional part into the promotion of Environmentally Sound Management (ESM) or it could be content of a COP to get politicians involved. They could further act as multipliers to spread the information.
- A possibility to emphasis the importance of terminology is the integration of a glossary in each publication of the Basel Convention.

An essential point is, that the improvement of waste prevention and minimisation is not just an implementation but rather an integrated process in line with existing processes for waste prevention and minimisation or sustainability.

1 Introduction

On a global scale, the volume of domestic and hazardous waste is enormous. Growing waste amounts postulate an enhancement of waste prevention and minimisation. Just 28 parties of the Basel Convention reported that an aggregate total of 182 million metric tonnes of hazardous and special wastes were generated in 1997. [GEISER 2003] Total waste quantities continue to increase in most European countries. Municipal waste arisings are large and continue to grow [EEA 2003B]. Waste quantities in most countries are growing faster than private consumption does, therefore waste generation per Euro spent by households is increasing [EEA 2002, p.7]. Waste generation in Denmark increased between 1994 and 2000 about 17 %. In Ireland the increase of household and household-like waste was 60 % in five years. In the Netherlands the total waste generation increased from 51 mio. t per year in 1990 up to 59 mio. t in 2000 about 17 %. The prognosis of future waste generation also shows an increasing trend. The Danish environmental agency forecasts an increase of the total waste generation of about 27 % between 2000 and 2020. [COMMISSION OF THE EUROPEAN UNION 2003, p.63].

Also the recycling of wastes increases. Thus the recycling of paper in the 15 EU Member States and Norway has increased from 35 % in 1985 to 49 % in 1996. But at the same time, however, the total quantity of paper incinerated or disposed on a landfill has also increased due to the growth in consumption of paper and cardboard. [EEA 2002, p.7]

The concept of waste prevention is not entirely new nor is the practice. In the chemical industry the idea goes back 100 years when prevention was called “yield improvement” e.g. making more products with the same amount of raw material. [OECD 2000]

Many countries have made efforts for waste prevention and minimisation. Examples from seven European countries within the sectors municipal waste and industrial waste have been analysed in a study of the ECO-INSTITUT [1999]. Many links to case studies on pollution prevention in general are given on the website from the European Topic Centre on Waste and Material Flows (ETC/WMF) [ETC/WMF 2003A].

For an effective implementation of waste prevention and minimisation it should be envisaged to use the experiences of different regions or countries. Thus the know-how, skills, processes and technologies should be transferred from one country or one region of the world to another if appropriate. The prerequisites for a transfer are the uniformity of terminology, information about concepts and instruments as well as the knowledge about the role of important groups and differences. Moreover, measures to be transferred need to be evaluated by corresponding indicators. This scoping paper generally addresses these issues.

2 Terminology

2.1 Terms

When regarding the terminology in the area of waste prevention and minimisation different terms are commonly used and a strict definition of a single term does not exist. Different studies concerning the aspect of waste terminology indicate that it is very important to use the same terminology. Besides the necessity to use the same terminology the waste hierarchy i.e. which kind of actions, treatments or measures favoured in each country is important to be considered. Subsequently, some definitions are generally presented as a detailed analysis would be too voluminous.

First of all the question what is meant by "waste" is shortly explained by some quoted definitions:

"Wastes are substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provision of national law". Basel Convention, [ETC/WMF 2003B]

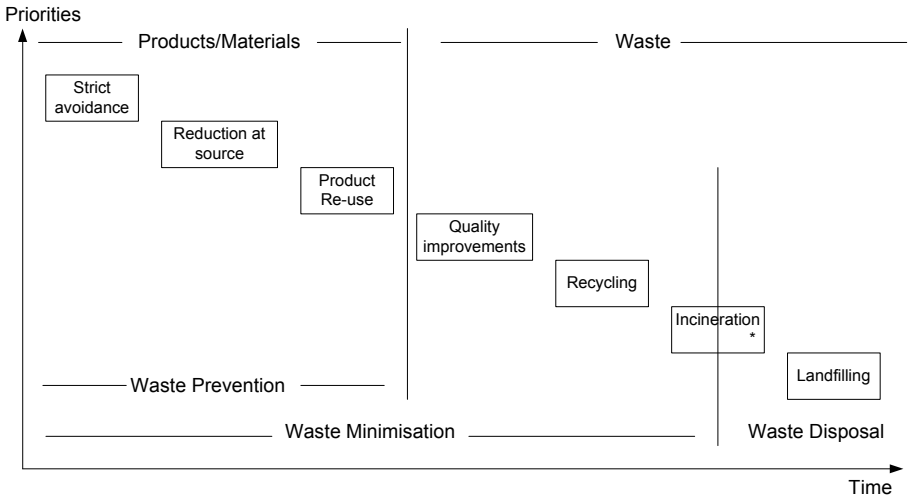
"Wastes refer to materials that are not prime products (i.e. products produced for the market) for which the generator has no further use for own purpose of production, transformation or consumption, and which he discards, or intends or is required to discard. Wastes may be generated during the extraction of raw materials during the processing of raw materials to intermediate and final products, during the consumption of final products, and during any other human activity. Excluded are: Residuals directly recycled or reused at the place of generation (i.e. establishment) and waste materials that are directly discharged into ambient water or air." OECD [ETC/WMF 2003B]

"Wastes shall mean any substance or object in the categories set out in Annex I which the holder discards or intends or is required to discard. The Commission has drawn up a list of wastes belonging to the categories listed in Annex I." EU Council Directive 75/442/EEC on waste, as amended by Council Directive 91/156/EEC, Art.1(a) [ETC/WMF 2003B].

Because of the certain ambiguity of the waste legislation, the European Court of Justice has been called upon to resolve a number of disputes, to interpret the waste definition.

In Figure 2-1 different terms to illustrate waste prevention and minimisation and their relation to each other are illustrated. This figure was elaborated by the OECD and is used also by the EU. Different countries already agreed on this, except for the problem that incineration is considered as minimisation in some countries and in others not.

The Figure 2-1 shows also the rough waste hierarchy of the different terms. Thus, avoidance, reduction at source and reuse are favoured in many countries, followed by quality improvement, recycling and lastly, incineration and landfilling. However, the detailed hierarchy of different actions, treatments and measures can differ among countries. Therefore, during a transfer different technologies or alternatives will be preferred in some countries (see Annex 1 for examples).



[modified after OECD 1998A and OECD 2000]

* The star in Figure 2-1 represents the fact that, in different countries, the incineration of waste is sometimes considered waste minimisation regardless if with energy recovery or without, some countries classify it as waste minimisation only with energy recovery but many countries never consider incineration to be a waste minimisation method.

Figure 2-1: Terminology in waste prevention and minimisation

2.1.1 Waste Prevention

According to Figure 2-1 waste prevention comprises the strict avoidance, the reduction at source and the product re-use. Waste prevention comprises activities to reduce the quantity, the hazard and/or the energy content of materials before they become waste. These activities are based on a life-cycle concept which includes production, consumption and distribution processes. They shall induce for instance a change of input materials, change of purchase, technology changes, change in design, good operating practices, product changes, introducing re-use or refill systems and miniaturisation. Reusing products means using the product again for the same or a different purpose, repairing items, selling or donating them. Waste prevention occurs before goods or materials are identified as waste. In general, it is more difficult to implement these types of activities and to measure their results than more traditional waste management activities. When addressing waste prevention, there is often a lack of basic data which can be used for monitoring waste management activities.

2.1.2 Waste Minimisation

The OECD definition of 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.” [OECD 2000, p.37]. In Figure 2-1 waste minimisation according to OECD is shown which includes waste prevention as defined above and in addition quality improvements and recycling. These activities concern materials which are already classified as waste. In 13 countries incineration or thermal treatment with energy recovery has been considered as waste minimisation whereas in four countries (e.g. Japan, France) waste incineration without energy recovery has been included in waste minimisation [OECD 1998B]. A European judgment from 2003 decided that incineration operations are considered as a disposal operation regardless of any energy recovery from waste [PIN 2003].

The EEA refers to the definition of the OECD [EEA 2002].

The EPA defines: Measures or techniques, including plans and directives, that reduce the amount of wastes generated; this term also is applied to reducing waste at its source, to recycling and other efforts to reduce the volume of waste going to landfills. This term is interchangeable with waste reduction. [EPA 2003A, EPA 2003B, ETC/WMF 2003C]

The definition of the UNEP is: Waste minimisation includes reducing waste at the source so that it is not generated, recycling and other means to reduce the amount of waste which must be treated/disposed. [UNEP DTIE 2001A]

The different institutions define waste minimisation more or less the same in this general sense except the classification problem of incineration.

2.1.3 Waste Recycling

According to the OECD “Recycling is the processing and use of wastes in production and consumption processes for an identical or similar nature” [OECD 1997A]. Examples for recycling are industrial melting of one-way glass bottles for the use in new bottles, melting of scrap iron into new iron products, the usage of old newspapers for production of sanitary paper products, aerobic or anaerobic treatment of organic household waste to produce agricultural soil [OECD 2000, p.37].

For the EPA recycling means any process by which wastes are collected, separated or processed and are returned to the economic mainstream in form of raw materials or products to be manufactured in the same or a similar product. An example is the collection of aluminium cans, melting them down, and using the aluminium to make new cans or other aluminium products. It excludes the use of these materials as a fuel substitute or for energy production. [EPA 2003C]

There are different stages of recycling depending on how the product or material is used after or during the recycling. Material recycling means the same or similar use of materials or products. Energy recovery means the use for instance as secondary fuel. However, the energy recovery is a point of discussion whether it is included or excluded in recycling.

The term on-site recycling means the use of material in the same process whereas off-site recycling means the use in other processes [OECD 1998B, p.6]. It is essential to clarify in detail which activities are included in the term “recycling” by different nations. Here, once again, a different hierarchy of the different recycling stages is possible in different countries [OECD 1998B]. For instance, in many countries on-site recycling had priority over off-site recycling, material recycling had a priority over energy recovery but in some countries the single measures have the same priority (see also Annex 1) [OECD 1998A].

2.1.4 Cleaner Production / Clean Technology / Pollution Prevention

The concept of Cleaner Production was introduced by UNEP Industry and Environment (UNEP IE). It stands for the continuous application and improvement of an integrated preventive environmental strategy for processes, products and services to increase efficiency and reduce risks for humans and environment [GTZ 1998, ETC/WMF 2003D]. According to UNEP IE the term comprises for production processes the efficient and economical handling of raw materials and energy, the removal of toxic and dangerous raw materials and the reduction of the quantity and toxicity of all emissions and wastes before they leave the production process. Concerning products the cleaner production strategy focuses on the reduction of negative impacts on the environment, the health and safety over the entire life cycle of the

product: beginning at raw materials extraction up to the final disposal. [GTZ 1998, UNEP DTIE 2001B]

The definition of OECD is: "Clean Technology is the installation or a part of an installation that has been adapted in order to generate less or no pollution. In Clean Technology as opposed to end-of-pipe technology, the environmental equipment is integrated into the production process." [OECD 1997B]. OECD uses Cleaner Production technologies synonymous with Clean Technologies.

"The key difference between traditional pollution control and Cleaner Production is the timing. Pollution control using 'end-of-pipe' measures is an after-the-event, 'respond to remedy' approach. In contrast, Cleaner Production is a forward-looking, 'anticipate and prevent' strategy. The underlying idea is that it is cheaper, healthier, and better to prevent environmental pollution in the first place rather than to control contamination after it has been generated." [ETC/WMF 2003D]

Cleaner Production is a broad term that encompasses what some countries/institutions call eco-efficiency, waste minimisation, pollution prevention or green productivity, but it also includes additional aspects. Cleaner Production refers to a mentality of how goods and services are produced with the minimum environmental impact under present technological and economic limits. Cleaner Production does not deny growth, it merely insists that growth be ecologically sustainable. It should not be considered only as environmental strategy, because it also relates to economic considerations. [UNEP DTIE 2001B]

The EPA defines Pollution Prevention as the source reduction of waste including practices that conserve natural resources by reducing or eliminating pollutants through increased efficiency in the use of raw materials, energy, water and land. It includes any practice that reduces the quantity and/or toxicity of pollutants entering a waste stream prior to recycling, treatment or disposal. [UNEP DTIE 2001A] It is a strategy that emphasizes reducing the amount of pollution or waste created, rather than controlling waste or dealing with pollutants after they have been created. [EPA 2003D]

The terms Cleaner Production (CP) and Pollution Prevention (P2) are often used interchangeably. The distinction between the two tends to be geographic: the term Pollution Prevention tends to be used in North America, while Cleaner Production is used in other parts of the world. Both, CP and P2 focus on a strategy of continuously reducing pollution and environmental impact through source reduction. Waste treatment does not fall under the definition of CP or P2 because it does not prevent the waste generation. [UNEP DTIE 2001B]

Pollution Prevention and waste minimisation terms are often used interchangeably. Pollution prevention in terms of waste prevention means not generating waste in the first place by reducing it at the source. Waste minimisation is a broader term that also includes recycling and other means to reduce the amount of waste which must be treated/disposed of. [UNEP DTIE 2001A]

By reading this explanation one can comprehend that there are a lot of different terms and ideas how the problem of waste avoidance can be treated. The different terms overlap each other and have the same overall aim but in detail they can differ.

2.1.5 Zero Emission

Generally, the term Zero Emission has two different meanings:

The concept promoted originally by the United Nations University in 1994 is an integrated system in which all industrial inputs are used in final products or are converted into value-added inputs for other industries or processes. This concept does not assert that all emissions of a set of industrial processes can reach precisely zero. The system's perspective has to be amplified so that an inevitable emission from a given process is viewed in the context of other industrial and natural processes utilizing this waste. This can possibly lead to effectively "zero" emissions, meaning no measurable impact on the environment. [ZERO EMISSION FORUM 2002]. This definition is used for instances in Japan. There, several industries say that they have achieved "zero emission" for industrial waste. They understand this as reduction of waste and by-products from industry as a whole to an absolute minimum. This includes also the recycling of the items. But it is not possible to retrace which kind of processes they really mean when saying recycling. It could also be energy recovery which is not accepted as recycling measure in other countries. One of their methods to achieve zero emission is renting items or outsourcing [FUJITSU 2004, JAPAN INFORMATION NETWORK 2004, SOMPO JAPAN 2004].

Zero Emission defined by ICT/IKP/PE[2] is not the demand for processes converting the complete material because this would scientifically and technically not be practicable. In fact, Zero Emission is an integrated concept for the future including the protection of the environment, saving natural resources, securing economic interests, providing employment and educating the youth. By creating this situation where everybody wins, the present and the next generation are strengthened. [ZERO EMISSION 2000]

2.1.6 Household Waste / Municipal Waste

According to EPA household or domestic waste is: "Solid waste, composed of garbage and rubbish, which normally originates in a private home or apartment house. Domestic waste may contain a significant amount of toxic or hazardous waste." [EPA 2003E]

According to the OECD "household waste refers to waste material usually generated in the residential environment. Waste with similar characteristics may be generated in other economic activities and can thus be treated and disposed of together with household waste." [OECD 1997c]

The EEA has followed the OECD definition of household waste. Subsequently, household waste is understood as waste from domestic households. Municipal waste is household-type waste collected by or on behalf of municipalities and household-type waste collected by the private sector.

Household waste is a concept linked specifically to waste generation, consisting of waste from a unique type of source: households. However, in practice, waste collected from households will often be mixed with similar waste from other sources such as offices or restaurants. Due to this mixed collection it is difficult for authorities to evaluate a precise statistic for waste actually generated by households. [EEA 2000]

[2] ICT: Frauenhofer Institute for Chemical Technology, IKP: Institute for Plastic Examination and Science, PE: Product Engineering GmbH

Generally speaking, municipal waste is a management and collection concept, because municipal waste means waste collected by or on behalf of municipalities. This includes wastes from households, commercial activities, office buildings, institutions as schools or governments, businesses. Because municipal activities can vary from one country to another and even vary from one region to another within countries, data and information on municipal waste must therefore be expected to be incomparable by nature. [EEA 2000]

2.1.7 Conclusion

During the investigation it was remarkable that there were several definitions of one country were not contradictory but complementary especially for the EPA. Another important aspect is that terms evolve over the time as the term “hazardous waste” in England. Due to the introduction of the catalogue of hazardous wastes the amount of this waste reduplicated between 1996/97 and 1997/98. [COMMISSION OF THE EUROPEAN UNION 2003, p.66]

Predominantly, there are similar general understandings of waste prevention and waste minimisation. One point of discussion is the classification of the incineration of waste. It should also be clarified which kind of treatments are really considered within recycling. Also the waste categories should be similar for uniform data collection. The European juridical disputes about the waste definition illustrate that the problems of terminology originate in the detailed interpretation of common terms. This should be analysed further.

Furthermore, the hierarchy of different treatments and measures (avoiding, re-use, recycling, etc.), and also within the single terms, e.g. recycling can vary in different countries due to policy approaches and ranking systems by which priorities are set. Therefore, in case of transfer different technologies or alternatives will be preferred in some countries.

The definition of household and municipal waste is principally similar in different countries but due to different municipal activities and collection structures the waste collected and considered in different areas is not corresponding. Hence, it is evident that for the data collection it is not sufficient to define the terms in the same way but also the practical realisation has to be evaluated and adapted before a comparison of data is possible (more details see chapter 8).

The introduced terms for the characterisation of different fields of activities and the direction of development are numerous and hard to be differentiated. Beyond, one can observe a term evolution after a new implementation of terms. Based on a sharply outlined meaning of the terms they develop further to larger meanings. [ICT & IKP & PE 1999] Therefore, the comparison of the different terms is not easy. Principally the terms Cleaner Production, Cleaner Technology, Pollution Prevention and Zero Emission point out a correspondence respectively an overlapping as regards the contents and the aims. However within the terms the single elements are differently weighted respectively single elements are included or excluded.

2.2 6-Level-Model

In general, waste includes all items that people no longer have any use for, this includes items people either intend to get rid of or are required to discard. Therefore, many items can be considered as waste like, for instance, household rubbish, sewage sludge, wastes from manufacturing activities, packaging items, discarded cars, old televisions, garden waste, old paint containers. As a consequence, waste usually is classified simply by its origin. The European Topic Centre on Waste and Material Flows, for example, differentiates waste into municipal waste, industrial waste, hazardous waste, construction and demolition waste, min-

ing waste, waste from electrical and electronic equipment, biodegradable municipal waste, packaging waste, end-of-life-vehicles and tyres as well as agricultural waste. [ETC/WMF 2004A]. Similarly, however less detailed, the Federal Statistical Office of Germany categorizes waste into municipal waste, slag from mining, waste from production industries, building demolition waste/excavated earth/road demolition waste/waste of construction sites and waste requiring special control. [FEDERAL STATISTICAL OFFICE 2004]

The above mentioned classification of waste, however, does not allow sufficient selective measures and treatments regarding waste minimization in closed loop systems. According to an economic perspective, e. g. the function of individual values respective relative prices to coordinate supply and demand of goods and services (price mechanism of the market), waste is better classified on a continuum of six levels ranging from valuable goods to undesirable, valueless waste. Depending on the respective classification different waste treatment activities can be recommended. Goods either remain in economic circulation directly or indirectly via recycling or leave the cycle via disposal. Furthermore, the classification of one and the same waste type usually is dependent on local, regional or national circumstances which affects the choice of waste prevention and minimisation instruments.

In theory, the described 6-Level-Model [BAUM & WAGNER 2000] controls the flow of waste fractions in an ideal way due to set market incentives. The model supports the identification of adequate waste prevention and minimisation instruments.

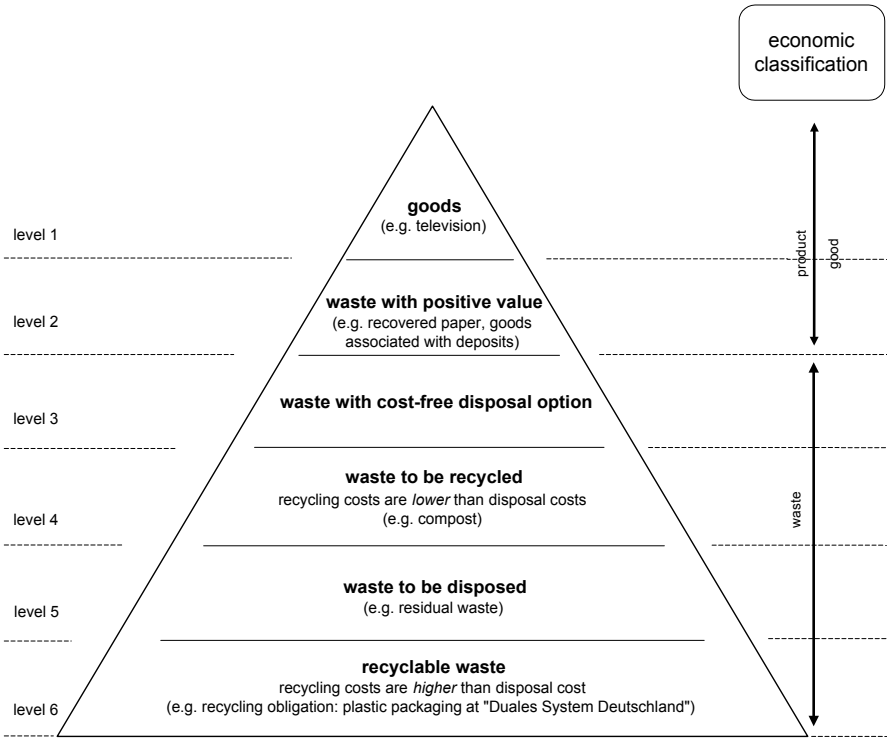


Figure 2-2: 6-Level-Model for Waste Classification

Level 1

The strongest motivation for keeping goods in a closed loop can be seen in their positive value (e.g. used TV set, used furniture). These goods are transferred to a new owner and usage is continued. Such exchange fosters closed loops and allows both seller and buyer to be better off.

Level 2

Similar incentive patterns are also applicable considering waste. This is particularly possible by introducing deposit-refund systems. A deposit leads to a situation where waste – at least legally – turns into a good. Incentive schemes similar to those of markets begin to work. Goods are likely to be returned back to the producer or the refunding institution and thus initiate circular flows. This level also comprises goods that are still ready to yield a revenue on the free market (e. g. beverages) although they are conventionally regarded as waste. The higher the value of those goods the stronger are the economic incentives and, of course, the more common is the existence of closed loops.

Level 3

Compared to level 1 and level 2 the incentives for returning waste at no charge are weaker in case there is no deposit. Waste in this context means goods which are – from the owners´ point of view – worthless, and thus, the owner has no interest to use it anymore. The motivation for passing back material such as packaging to the producer could be given by a reduced amount of residual waste and the respective savings of disposal fees. Admittedly, in many countries waste holders cannot save disposal fees on short notice because the fees depend on the size of the refuse bin regardless whether it is full or empty. Another incentive for bringing back waste at no charge is psychologically motivated. If the owner returns waste (that means worthless goods from his point of view, e. g. used batteries) to collecting points he will obtain a quiet conscience because he behaves ecologically friendly.

Level 4

The economic incentives are even weaker when recycling costs are involved whereby the costs for recycling on this level are still below the disposal costs. Like on the prior level the incentive is founded on disposal fee saving (opportunity cost calculation) which is less than that on level 3. Therefore, in Germany recent rises in disposal fees led to a high motivation for companies to declare all of their residual waste as waste to be recycled. This is possible since residual waste usually is a mixture of waste to be disposed and waste to be recycled which possibly cannot be separated into two or more discrete fractions for the reason of technical feasibility or economic reasonability. Waste to be recycled needs not to be treated domestically but can be transported to a place with lower disposal fees. Thus, a certain amount of waste to be disposed can get out of the country's reach and thereby possibly cause a higher negative ecological impact. Further, this evasion strategy withdraws quantity from the waste management system and results in higher disposal prices because of lower economies of scale in waste management plants.

Level 5

This level stores the residual waste to be disposed. Namely waste that cannot be categorized in one of the other groups. If economic and ecological reasoning correspond then this kind of waste has no positive recycling potential. Disposal is the preferred option.

Level 6

The last level contains waste that is recycled although the recycling costs exceed the corresponding disposal costs. If we presume rational decision making and behaviour level 6 would hardly exist as waste holders always would choose the cheaper disposal alternative. Therefore, this level simply exists due to certain legal recycling obligations for selected waste fractions. Economically this behaviour can only be justified by the fact that the present disposal fees do not include the valued external effects (impacts on the environment) appropriately.

As a consequence of the waste classification according to the 6-Level-Model different waste prevention and minimisation instruments appear appropriately. In each case they must be suitable to upgrade waste from one level to a higher level, e.g. from level 3 to level 2 by introducing a deposit refund scheme. Thus, the incentive to avoid or minimize waste would increase.

2.3 Effects of different and missing regulations

Because of the different development in the individual countries worldwide, they all have differently developed legislations. Particularly in the sector of waste prevention and minimisation the development of legislation is nearly proportional to the level of development in specific countries.

Below the possible effects on transfer due to differences of legal systems are analysed.

2.3.1 Legal systems

Germany, as a developed nation, has a detailed waste regulation. The essential law in regard to waste management is the Act for Promoting Closed Substance Cycle Waste Management and Ensuring Environmentally Compatible Waste Disposal (Waste Management Act - WMA). This law includes comprehensive regulations concerning waste minimisation. Regulations concerning waste minimisation are also included in the Federal Immission Control Act (BImSchG 1990).

China is a country with economies in transition. At present, there doesn't exist any regulation about waste prevention and minimisation. China is already fighting against the effects of an irregular waste generation. The urban waste in Beijing (with a total population of 13 mio. people) makes up to 3 mio. t/a with a yearly expansion of 5 to 8 % to more than 4 mio. t in the year 2007 [ENVIROTECH NETWORK 2003]. Due to the high quantity of waste, China is forced to take steps for the protection of its environment.

At the moment, Cameroon, as a developing country, has a framework law on environmental management. A provision of this law only bans the importation or transit of waste produced out of Cameroon and the responsibility to control the production of any wastes in Cameroon. However, there is no provision in this law on prevention and minimisation of waste.

2.3.2 Problems and possibilities

The fact that there is no legislation about waste management in several developing countries and countries with economies in transition causes the following problems:

- Binding laws of waste management oblige the respective countries and industrial sectors to take measures to prevent or minimise waste. In case of contravention, sanctions are the consequence. Countries like Cameroon or China, which don't have binding laws in

this sector, may realise the ambition and necessity of the conservation of nature and human health, but probably their industries and population are not willing to voluntarily implement technologies or change their behaviour. Therefore, it is necessary to develop and enforce regulations concerning waste management especially in developing countries and in countries with economies in transition to protect the environment.

- The lack or the insufficiency of a legal system in the sector of waste management is often responsible for the absence of a control system to assure the efficiency of a technology after its implementation.
- Furthermore, it could be a problem, that there is no consistent terminology as a result of missing legislation. Therefore, the transfer of technologies and knowledge could be difficult since inconsistent definitions of terms may effect confusion. In the worst case a plant or a machine will be build which will not work properly due to diverging input material in comparison to the construction of the plant or due to the fact that output material which doesn't correspond to the ideas of the beneficiary. An example therefore is the transfer of a plant for waste separation.
- Legal systems provide the scope for the transfer of know-how or technology because it is the basis for the effectual conclusion and stability of contracts. A prerequisite for companies and institutions to make investments abroad and thus transfer technology are steady political conditions.
- Due to different specifications in waste legislation the waste hierarchy of different actions, treatments and measures favoured in countries can be different. Therefore, different technologies or alternatives will be preferred in some countries during a transfer.
- A positive effect of missing guidelines could be the lack of limitations not contravening with the implementation of new technologies. The adaptation of these technologies can then create standards for laws which will be developed later on.

Regulations and laws in the sector of waste management particularly concerning waste prevention and minimisation should be developed and enforced. There are different ways how especially developing countries and countries with economies in transition can be supported in this process. On the one hand, guidelines for development and enforcement of regulations could be elaborated at international level, for instance in the frame of the Basel convention. With these guidelines national legislation should be developed. On the other hand, know-how can be created in each country by different possibilities such as consulting, National Cleaner Production Centres or Regional Training Centres. The study will further deepen these aspects.

A good example for an effective consulting process is the development of the environmental ministry in Guatemala. Besides the re-organisation of the protection of the environment in the public and industrial sector the environmental legislation should be reformed. This included the elaboration of new norms and regulations. [CLEANER PRODUCTION 2004]

2.3.3 Conclusion

To guarantee an effective transfer, it is primarily important to create a standardised terminology, to maintain the stability of legal systems in the respective countries and to develop unitary legislation in the long term for different countries.

3 Concepts for waste prevention and minimisation

3.1 In general

As there are a lot of different concepts, strategies and programmes aiming at least partially at waste prevention or minimisation the list presented here is an extract of the most important issues.

3.1.1 Basic Principles

Polluter Pays Principle

The Polluter Pays Principle in context of waste says that waste producers have to bear the costs for environmentally sound disposal of their waste. It allocates social costs of environmental impacts to the responsible causers (distribution function) and thus, prompt them to take these costs into their price calculation. Further, this principle effects incentives for polluters to take steps before negative environmental impacts can result (incentive function) i.e. waste prevention and minimisation.

Precautionary Principle

Concern of the Precautionary Principle is not only an averting of imminent danger but also detecting and preventing environmental impacts on an early stage (risk management). The Precautionary Principle aims at the protection of natural resources in the long term and is thus an important element of a sustainable development. Moreover, this principle corresponds with the idea of closed loop waste systems since it prefers waste prevention and recovery compared to waste disposal. A lack of total scientific certainty should never be an excuse for inaction where a certain level of threat has been surpassed.

Co-operation Principle

Co-operation Principle means that in case of important environmental affairs concerned and interested social groups should participate in the preliminary decision process. Thereby a high degree of experience and know-how shall be achieved as well as existing clash of interests shall be reduced in advance. Further, an early participation of all kinds of stakeholders in the decision making process can foster ecological awareness and education in the field of environmental protection.

3.1.2 Integrated Pollution Prevention and Control (IPPC)

Integrated Pollution Prevention and Control focuses on the shift from media-specific to integrated permitting. For instance, it is increasingly applied in the European Union. Since 1996 the Integrated Pollution Prevention and Control Directive focuses on an integrated control of environmental emissions, for all environmental media, rather than on regulating individual media problems. It simultaneously aims to reduce natural resource and energy use, exposure to hazardous substances and releases of pollutants by economic activities. The Directive includes common rules on integrated permitting for the industrial installations covered by the Directive. Without an authorisation (permit) from the authorities in the EU countries, they are not allowed to operate. Perhaps the most important feature of the IPPC approach is that the emission standards are based on best available techniques (BAT) that are currently

available. The regulator does not force industry to apply a specific technology. However, the plant should meet emission limit values based on current best available techniques.

In many cases BAT means quite radical environmental improvements and sometimes it will be very costly for companies to adapt their plants to BAT. Therefore, the Directive grants installations an eleven year transition period. BAT bulletins will be elaborated by the IPPC bureau in order to assist the licensing authorities. But the final decision will still remain with these authorities. [EUROPEAN COMMISSION 2004]

3.1.3 Extended Producer Responsibility (EPR) / Product Stewardship

Extended Producer Responsibility or Product Stewardship means that the manufacturer is responsible for various aspects of the product's life cycle, beyond just the manufacturing stage. EPR aims to achieve environmental improvements throughout the life cycle of a product. The basic principle is to extend the responsibilities of the manufacturer not only to the way of production of goods or what performance standards they meet but also to take-back, recycle and finally dispose of goods. Producers bear responsibilities such as covering the cost for end-of-life management of their products (financial responsibility), being involved in the physical take-back of their products (physical responsibility), and informing waste managers of the content of their waste (informative responsibility).

Concrete forms of these responsibilities include: take-back of end-of-life products; the establishment of take-back sites/infrastructure for the end-of-life management of products; meeting recycling targets; the environmentally sound treatment of end-of-life products (physical and/or financial); the ban of use of certain material and providing information to consumers on the content of the products. Producers accept their responsibility when they design their products to minimise life-cycle impacts and when they accept legal, physical and/or economic responsibility for the environmental impacts that cannot be eliminated by design. The Netherlands were the pioneers in this field. [ETC/WMF 2003E]

3.1.4 Integrated Product Policy (IPP)

Due to several activities in different nations a variety of interpretations of the term Integrated Product Policy (IPP) exists. The term IPP bases on an European Workshop in 1998. The global objective of IPP is to continually optimise products and related services to reduce their impacts on environment or humans during all phases of a product's life-cycle by taking action where it is most effective. The life-cycle of a product covers all the areas from the extraction of natural resources, through their design, manufacture, assembly, marketing, distribution, sale and use to their eventual disposal as waste. At the same time it involves many different actors and institutions such as designers, industry, marketing, retailers, consumers and disposal services. IPP attempts to stimulate each actor and institution of these phases to improve their environmental performance e.g. creating markets for environmentally sound products, transmitting information up and down the product chain. This is only possible by a variety of instruments – both voluntary and mandatory – that can be used to achieve this objective (see chapter 4.2). These include measures such as economic instruments, substance bans, voluntary agreements, environmental labelling and product design guidelines. [BUSINESS AND SUSTAINABLE DEVELOPMENT 2003, ETC/WMF 2003E, EUROPEAN COMMISSION 2003] The legal basis for the European IPP framework is in development. The IPP approach is increasingly used in the member states of the European Union and receives attention in international organisations like the UN Commission on Sustainable Development.

3.1.5 Cleaner Production (CP), Pollution Prevention (P2), Green Production (GP)

Green Productivity (GP) is similar to Cleaner Production (CP) and Pollution Prevention (P2) (see chapter 2.1). GP is predominantly used by the Asian Productivity Organisation (APO) to address the challenge of achieving sustainable production. GP emphasises stronger on soft factors than on corporate culture and management. [GTZ 1998, p.8]

The concepts of these three terms stand for a strategy to improve processes, products and services by technical, organisational and educational measures as evaluation and improvement of technologies, substitution of polluting products by non-polluting products, simplification of packaging or redesign of products, changes of the conscience of the employees, environmental management and the adjustment of the economic framework [GTZ 1998]. These measures will lead to an optimised and efficient use of resources. Therefore, it is a 'win-win' strategy because it protects the environment, the consumer and the worker while improving industrial efficiency, profitability and competitiveness. [UNEP DTIE 2001B] Companies applying waste reduction have saved hundreds of millions of dollars and used it to catalyse employee involvement and eliminate the need for expensive end-of-the-pipe technologies. [EPA 2003F]

A possible procedure for implementing these concepts could be the following:

- Preparation (positioning of a team, definition of the process steps, identifying and choice of waste intensive process steps)
- Analyses of the process steps (elaborate material flows, material and energy balances, economic evaluation of waste streams)
- Developing technological possibilities
- Choosing realistic alternatives (analyses of technological implementation, economic evaluation, evaluation of environmental aspects)
- Choice of the best solution
- Implementation of the solution
- Monitoring the implementation and evaluation of the results [GTZ 1998, p.8]

3.1.6 Strategic Waste Prevention

Strategic Waste Prevention is a long-term policy concept within a resource management and sustainable development perspective. Strategic waste prevention works toward the reduction of absolute waste amounts, hazards and risks, and is characterised by at least four aspects subject to continual refinement over time:

- A life-cycle perspective for identifying the policy intervention points linked with the highest waste preventing effects.
- A material-differentiated approach that links waste prevention targets, instruments, and performance evaluation approaches to different types and classes of material flows.
- The substantive integration of social and economic aspects into environmental policy discussions on waste prevention. This can include increased integration of stakeholder consultation during programme design.
- Institutional mechanisms that facilitate co-operation across traditional structures in ways that induce greater waste prevention and overall policy synergy. [OECD 2000]

It is supported by different policy concepts such as Eco-Efficiency, Industrial Ecology, Integrated Pollution Prevention and Control, Extend Producer Responsibility and Integrated Product Policy.

Strategic Waste Prevention is multi-faceted, having links to and being driven by the application of other evolving concepts. Table 3-1 shows the complex structure to which strategic waste prevention may apply to, how it can be approached and who could be involved.

Table 3-1: Strategic Waste Prevention [Source OECD 2000]

What? (physical scope options)	**How?** (possible approaches)	**When?** (policy programmes)	**Who?** (actors/stakeholders)
Macro-level: Material inputs and material outputs Product-based Material class-based Waste stream based (municipal, industrial, commercial, hazardous)	Institutional arrangements Legal/voluntary/economic knowledge creation Participatory consultation Multi-factor assessments: - economic, social, environmental management activities -procurement decisions	Strategic target setting Instrument choice & application Performance evaluation Programme and policy adjustment	National, regional, local government Private sector Consumers Media Financial institutions Academia
Where? refers to geographic or organisational scope to which a waste prevention programme is applicable: economy-wide, sector-level, firm-based, municipal-level, household-level.			
Why? refers to the objective of attaining some or all of the benefits potentially associated with an envisaged or existing prevention programme.			

3.1.7 Eco-Efficiency

The term Eco-Efficiency was established in 1992 by the Business Council for Sustainable Development. Eco-efficiency “is achieved by 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.” [WBCSD 2004]

Since then many companies, governments and non-governmental organisations have dealt with this theme and have therefore described a lot of different definitions and examples. The short definition which is generally accepted is: to create more value with less ecological impact and less resources. That means the combination of economic and ecologic efficiency. But there is no universally valid definition. [IMU 2003].

Concrete methods with measurable parameters or indicators need to be developed so that this concept can be used by politics, society and economy. Examples for possible methods are MIPS (Material Input per Service Unit), environmental cost accounting, flow-cost-accounting, life cycle analyses, material flow analyses, eco-efficiency analyses.

Business is achieving eco-efficiency through:

- Optimized processes - moving from costly end-of-pipe solutions to approaches that prevent pollution in the first place and maximise the use of renewable resources.
- Functional extension - companies are manufacturing smarter products with new and enhanced functionality and selling services to enhance the products’ functional value.
- Waste recycling - using the by-products and wastes of one industry as raw materials and resources for another, enhance material recyclability.
- Eco-innovation - manufacturing "smarter" by using new knowledge to make old products more resource-efficient in production and use.
- New services - for instance, leasing products rather than selling them, which changes companies' perceptions, spurring a shift to product durability and recycling.
- Networks and virtual organisations - shared resources increase the effective use of physical assets. [WBCSD 2004]

These ideas are not new but Eco-Efficiency combines them for the purpose of more efficiency. Eco-efficiency is sometimes used interchangeably with Cleaner Production.

3.1.8 Industrial Ecology (IE)

Industrial Ecology is a concept for new patterns of industrial production and is closely related to the Cleaner Production concept. Industrial Ecology examines local, regional and global uses and flows of materials and energy in products, processes, industrial sectors and economies. It focuses on the potential role of industry in reducing environmental burdens throughout the product life-cycle. IE exploits the ecology analogy by placing industrial activity in its environmental context and by drawing on nature as a model. One of the most important goals of IE is to make one industry’s waste another’s raw material-something. [OECD 2000, p.50, UNEP DTIE 2001A]

3.1.9 ISO 14001 / EMAS

ISO 14001[3] is an international norm for an environmental management system. EMAS is the European version of it (European Eco-Management and Audit Scheme). With ISO 14001 and EMAS companies and other organisations introduce and enhance a management system which allows to measure, report and improve their environmental impacts. EMAS includes more requirements than ISO 14001 especially on reporting. In so called environmental examinations internal persons in charge regularly check in each department whether the legal guidelines and internal aims are achieved. In addition, external auditors check whether the requirements of the norms are fulfilled. If they are the company or organisation receives a certificate. This can be profitable for the image of the company or organisation and it can simplify to obtain administrational permissions. These examinations are redone at least every three years to renew the certificate.

3.1.10 Environmental Technology Assessment (EnTA)

As Environmental Technology Assessment (EnTA) is a descriptive assessment of a technology, various stakeholders can use it in different ways. EnTA focuses on identifying and evaluating both specific and broader environmental impacts generated by a technology, examines the wider technological process over its entire life cycle and then determines the likely implications for the environment. The assessment is described by the acronym “DICE”:

- **D**escribe the proposed technology intervention, any alternatives, their requirements, and the operating environment;
- **I**dentify the pressures the technology places on the environment;
- **C**haracterise the environmental impacts these pressures may cause; and
- **E**valuate the overall consequences of the impacts, in light of local conditions.

EnTA provides a particularly valuable tool for determining whether a technology will meet specific performance criteria. For a precise procedure see Annex 2. [HAY 2004]

3.1.11 Material Flow Analysis (MFA)

Analysing material flows to find out where the materials remain is not new. Materials can be specific compounds (e.g. emissions as CO_2, heavy metals or toxic substances), or individual resources (e.g. timber or crude oil). If the analysis is done within a company, it is known as input-output analysis or material balance. If it is done on a macroeconomic level (e.g. country, city or region) it is the Material Flow Analysis whose origins go back to 1992. [ETC/WMF 2003E]

Material Flow Analysis refers to the accounting of materials throughout the entire cycle of economic activity from extraction, production, distribution, and consumption to final disposal. MFA is suggested as an accounting tool to monitor waste and measure material flows, in order to establish quantitative basis for measuring pollution prevention.

Conventional waste policies have largely directed their attention to particular types of “wastes” as defined by national or international regulation. MFA does not start from a predetermined list of problematic materials as referenced by laws or regulations. MFA is based

[3] ISO: International Standards Organisation

on the more over-arching input-output rule so that it can give a better understanding of the origins of these wastes, and thereby provides hints for possible intervention to prevent their creation in the first place. [OECD 2002, p.87]

3.1.12 Ecological Associations and Initiatives

There is a variation of possible associations and initiatives to improve environmental impacts in general. These initiatives can also be a platform for discussions about waste prevention or minimisation problems and implementation, and for the development of regional programmes on waste prevention or minimisation.

There are for instance programmes which involve several companies from the same municipality with the local government participating as a player. A good example for this approach is the Austrian ECOPROFIT® model. The term stands for "**ECO**logical **PRO**ject **F**or **I**ntegrated Environmental **T**echnology" and is a programme for sustainable economic development. The basic idea of ECOPROFIT® is a win-win-model, using integrated environmental technologies to strengthen businesses economically and simultaneously improve the local environment. Enterprises are enabled to cut their costs through investments into operational environmental protection and to increase their eco-efficiency. An important factor in the success of ECOPROFIT® is the special way local authorities, businesses and consultants work together through common training programmes and networking. This strong co-operation enables an effective flow of information and considerable synergies. An international network was established so that ECOPROFIT® projects are founded in several international cities or municipalities. [CLEANER PRODUCTION CENTER AUSTRIA 2004]

In several German federal states environmental pacts or alliances between authorities, businesses, consultants, institutes and universities have been founded with the aim to intensify the environmental protection on the basis of voluntary, personal responsibility and co-operation. Especially small and medium sized companies shall be contacted locally to impart the advantages of environmentally sound operation. In Bavaria for instance circa 60 projects have been lanced from protection of resources up to environmental management, in addition a variety of voluntary measures have been assured by the industry (see chapter 4.2.2.7).

For the transfer of know-how and technology, for instance, the Bavarian Innovation and Co-operation Initiative of Environmental Technology (BAIKUM) was founded by the Bavarian government in co-operation with the Chamber of Commerce and Industry and other Bavarian initiatives. The aim is to support small and medium sized companies to develop new markets for environmental technology through joint national and international projects. The advantage of this initiative is the network of several institutions and companies for better competitive position.

Another approach can include the establishment of eco-industrial parks. In such industrial parks, individual organisations can jointly share some pollution prevention infrastructure, and industrial ecology is tested and implemented.

Partnerships of convenience formed by different companies concerned with waste management or disposal and municipalities or settlements, can also support waste prevention and minimisation measures.

3.1.13 Re-use

Products and items can be re-used on different levels. At the first level there is the multiple use of the original product for its original purpose then the original product can be used for an alternative purpose with or without reconditioning. If the product is broken it should be repaired so that it can be used again, either for the same purpose or another. If someone doesn't want to use the item anymore then it can be sold on flea markets, garage sales, in second hand shops or in the internet, or it can be donated. One example are packagings being saved by re-filling. For instance, there exist shops for re-filling of pens, shampoo, acid and oil or alcohol.

In manufacturing processes there are many possibilities to re-use materials, for instance when a raw material is not used entirely in the process it can be led back into the process, the same applies to process water. Industry can develop or manufacture items which can be re-used or re-filled easier than others.

Both industries and consumers are demanded to support re-using products.

3.1.14 Life Time Prolongation

A prolongation of the life time of a product or an item retards the production of a new product. The prolongation can either be achieved by better maintenance of the product or by an improved design for more durable products or components, for instance exchangeable modules which allow an adaptation to technological progress or an exchange in case of mal-function. Examples are the usage of re-filled or re-manufactured toner cartridges, replacing disposable cups with ceramic mugs in coffee machine, replacing disposable grocery bags with re-usable shopping bags. So, once again, industry and consumer are demanded to participate.

The life time prolongation can contradict innovation and contradicts the present trend of the consumer society which favours short-lived products such as mobile phones or other fashion products. The problem is that the economy doesn't have any interest to invert this trend because thereby they can sell more products. On the other hand products with a longer life-cycle are usually of higher quality and therefore more expensive so that the economy gains more in comparison to general products - but only once.

That means that for an implementation of this relatively simple idea a general change in consumption patterns is necessary and it is essential to find an environmentally sound way for economic growth.

But prolongation of the life time of products must not always be positive. Due to technological progress the usage of old products, e.g. washing machine, might consume more energy, water, etc. than the production of a new product including the usage. To answer the question whether the substitution or the further usage of a product is reasonable, a Life Cycle Assessment (LCA) can help (see chapter 3.2). In the case of a refrigerator such an LCA was performed by BASF concluding that the substitution of a refrigerator consuming more than 300 kWh/year is reasonable. If the old one consumes less than 300 it should be used further on [BASF 2002].

3.1.15 Recycling

In many countries there are a lot of different activities and technologies for the recycling of waste. Recycling facilities are usually subject to licensing procedures but there are not always binding technical standards. Therefore, recycling standards vary from country to coun-

try or even within countries which also leads to different prices charged for services. Thus waste could be transported to the cheapest treatment place which results in low-quality secondary materials [OECD 1998B].

When speaking of re-cycling it is important to consider the number of life-cycles. Recycling is always some kind of a down-cycling meaning that parts of the valuable resources are transformed into less valuable items. Completely closed loops are not possible due to physical and economical reasons. The cascade of product quality is pointed out in the example of the recycling of polyolefines (Figure 3-1). [WITTMANN 1994, p.16] Recycling is more efficient the more genuine the material is. Therefore, selected waste collection is an advantage. This implies also that mono-structured components of products should be aimed at instead of bonded systems because this strongly facilitates recycling.

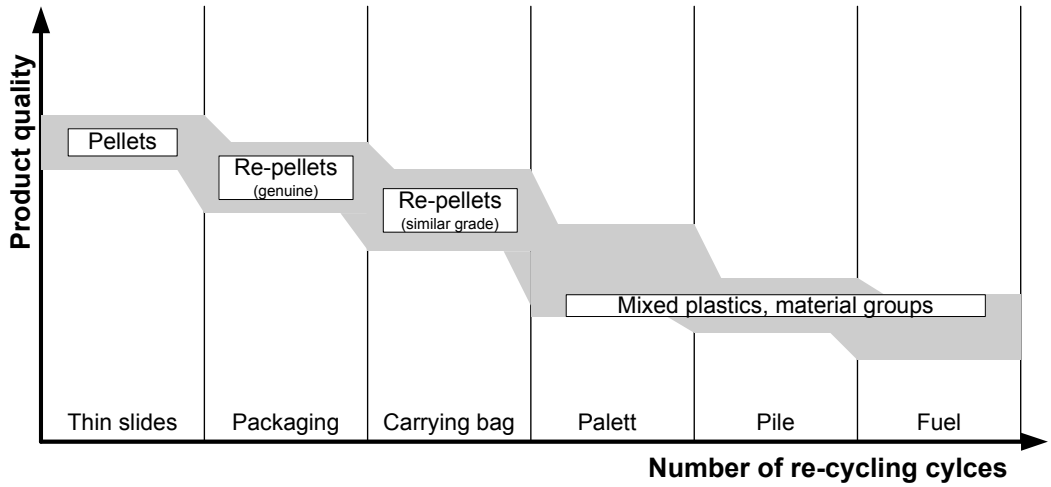


Figure 3-1: Down-cycling of polyolefines [Source WITTMANN 1994, p.16]

Waste from industries and commerce is the least complicated to collect and recycle, household waste is more complicated to recycle due to its diversity, collection mode and arise in small quantities at many places. Therefore, two thirds of total European municipal waste is still landfilled [EEA 2002, p.11-13].

To know whether recycling is reasonable for a specific waste stream, product or material, it is essential to evaluate the net ecological impact of these activities. On the one hand recycling activities lead to positive ecological effects, on the other hand the activities themselves lead to more resource consumption and sometimes even have a negative ecological impact. On the input side positive ecological effects are achieved by saving natural resources since primary resources are substituted by secondary resources. On the output side recycling decreases emissions of residuals. However, the mentioned effects only describe an ecological gross impact as the processes themselves bring along activities that may have a negative ecological impact. Only with a positive net impact on the environment recycling will become reasonable as shown in Figure 3-2. The evaluation of the net ecological impact is complex. It could be done in form of a LCA (see chapter 3.2).

	Material and/or energy savings gained from recycling activity on the input side through material and/or energy substitution
+	Protection of the absorbing medium on the output side by recycling activities that decrease emissions
./.	Additional material and/or energy input caused by recycling activity
./.	Additional emissions towards the absorbing medium caused by the recycling activity
=	Net ecological impact of the recycling activity

Figure 3-2: Net ecological impact

3.1.16 Pay As You Throw (PAYT)

Pay As You Throw (PAYT) is a system for municipal waste in which the waste producer pays for the collection and disposal of its waste proportionally to the amount of waste produced. That means that the fees are calculated per weight and no longer per capita, household or per container. This is an incentive for the polluter to reduce its waste.

Usually there are containers for household waste or municipal waste which are emptied corresponding to a given time-schedule. Here the polluter pays per emptying of the container regardless how much waste he really produced. So there is no incentive for waste prevention or minimisation.

The easiest way to improve this is the possibility that the polluter can choose whether he wants his container to be emptied or not. That means for instance that one can decide to let the container being emptied only every second time of collection if the container is not full yet and thus one pays less. This means a higher organisational effort for the bills of taxes.

More complicated systems detect the weight of waste during emptying the containers. Therefore, each container needs a code for identification of the corresponding producer. On the one hand, the installation of these techniques is expensive, on the other hand, the producer has to have a possibility to protect his container against illegal disposal of waste by third parties for which the owner of the container would have to pay for.

The EPA speaks of ten years of good experiences in the USA so that the system shall be introduced not only in communities but also in big cities. [EPA 2004]

3.1.17 Transfer – concepts, aspects and demonstration projects

Some of the above described concepts are quite complex and the implementation problem especially in developing countries or countries with economies in transition might be represented by knowledge deficiencies. For promoting and facilitating the implementation of these concepts the communication and qualification of the people appears to be a prerequisite. Therefore, capacity building is an essential factor for development.

Principally, there are different possibilities to provide information. First of all guidelines or “do it yourself” manuals or checklists can be distributed. The major problem, however, is that

somebody in a company must be responsible to introduce the necessary following steps. Another possibility is the training of people in a consultancy process. The basic idea is that the consultants provide the necessary information as relevant background for decision makers. This process can be divers. International experts may implement everything in detail in each company or international experts may only coach and qualify national experts who in turn qualify national people in the individual companies.

But there are differences between trainings. A single course for people is good to inform them. But an approved approach is the coaching over a longer period of time like three to four months to set up a process. The consultancy process is organised for distinct industrial sectors (e.g. mining, metallurgy, paper industry, chemical industry, etc.) to gather responsible people from companies concerned. Within the process trainings will be held at the beginning and further on from time to time. In the meanwhile participants have the possibility to implement the approaches in their companies.

- Depending on the previous knowledge of participants the consultancy process normally starts with a general introduction of possible strategies, concepts and their potentials as well as national and/or international examples.
- At first material flows will be analysed for evaluating inputs and outputs of processes or the company.
- After applying the material flow analyses in each company people come together in workshops to exchange their experiences, discuss and analyse problems and give hints. Thus, team work is supported which can give motivation for the own work.
- In a second step, starting points for measures will be evaluated.
- In a third step the evaluated measures will be implemented.

Experts should also visit the companies to assist analysing, evaluating and organising teams responsible for the implementation of the measures, collecting basic data and identify measures. A documentation should be sent to all experts and companies so that synergies can be used. In following visits further technical and organisational measures can be determined and the company can be advised for implementation of solutions and of the necessary monitoring. [GTZ 1998, GTZ 2004]

Within this consultancy process it is essential that the experts don’t stick to their original plan or aim of the project but that they are flexible and adaptable to the conditions and knowledge on site.

The problem of this kind of procedure is that a financier has to be found because at the beginning the companies will not have the possibility to pay the costs even when they have savings afterwards. Thus, the companies already have to provide the working time of the people and in case a change-over to new technologies is necessary also these costs.

But changes do not inevitably need to be costly. In a first step only small activities connected with no or few costs could be implemented such as changing behaviour, organisational structure, implement multidisciplinary teams or raise the awareness of each employee that every single person is responsible. International companies producing in developing countries or in countries with economies in transition such as automotive manufacturers have already set up demands for their suppliers in the field of quality. A possibility to increase the willingness to participate in an above explained programme is an enlargement of demands for suppliers in the field of environment.

These described consultancy processes are demonstration or pilot projects. These projects as well as case studies are useful and necessary to start a dynamic process for further projects in the respective countries. Examples for successful initiatives on waste prevention are given on the homepage of the European Topic Centre on Waste and Material Flows [ETC/WMF 2004B]. Pilot projects are essential especially in developing countries and in countries with economies in transition. Demonstration or pilot projects as well as case studies can be manifold. They can deal either with an improvement of organisational, industrial or administrative structures or technical equipment can be realised. When these kinds of projects are successful they are a good example for the expenditure of the respective structures or equipments in further projects.

3.1.18 Conclusion

There is still some discussion among theoreticians concerning the differences and similarities between the concepts and instruments. However, from the point of practical implementation, the differences are small, with most of the concepts sharing a common emphasis on:

- No more end-of-pipe solution envisaged but life cycle approaches which means integrated, preventive environmental strategies to production processes and to products
- The simultaneous achievement of economic and environmental benefits
- Minimisation of risks to human health and environment
- The sustainable use of natural resources [UNEP DTIE 2001A]

The concepts and instruments differ in the significance of waste prevention or minimisation. Some of them focus on waste related issues as Strategic Waste Prevention, Re-use or Life Cycle Prolongation. Others have a more general environmental background as environmental management systems or IPPC and IPP including in this respect also waste prevention and minimisation. Another distinction is that many of the concepts are basically applied at the firm or organisational level (IPPC, EMAS, IE, CP, etc.), whereas IPP, PAYT, Re-use etc. inherently engage multiple actors, including consumers.

One could assume that the concepts or instruments are competitors. But this is not the case because many of them complement each another. Several examples of successful merging of different concepts exist and experience shows that, for instance, a Cleaner Production program can be an integral part of work towards an EMAS or ISO 14001 certification. [ETC/WMF 2003E] Strategic Waste Prevention and IPP include a mixture of different concepts and instruments.

From the technical point of view it is important to have general uniform standards e.g. for recycling facilities or best available technique. Standards for best available techniques are for instance worked out in the EU in relation to the IPPC Directive.

The requirements for the implementation of the instruments are multidisciplinary – technical, economic, environmental and social conditions and processes can often be complex.

3.2 Special focus: the role of Life Cycle Assessment (LCA)

Several of the concepts, strategies and operational instruments mentioned above include the life cycle approach. This emphasizes the importance of thinking in life cycles. A Life Cycle Assessment is a technique for compilation and evaluation of the inputs and outputs, and thus the potential environmental impacts associated with products, processes or services throughout their life cycles [ISO 14040]. This cradle-to-grave analysis begins at the extraction of resources, through production of materials and products over the use of products, processes or services up to discarding, reusing or disposing. The environmental burden covers impacts upon the environment, including extraction of resources, emissions to air, water and soil. LCA are most often comparative studies to compare different products, processes or services. Concerning products the basis for comparison is the function provided by the products and not the products themselves. LCA is, as far as possible, quantitative in character, where this is not possible, qualitative aspects are taken into account. The cradle-to-grave approach is important so that there is no generation of a “problem shifting” that means that one environmental problem is not solved by shifting it to another stage in the products life time or to another media. For instance, manufacturing a car out of aluminium instead of steel means that its gasoline consumption is reduced due to less weight but the production of aluminium requires more energy than that of steel. Only when all these facts are taken into account it can be judged whether a car made of aluminium is truly more environmentally friendly than one made of steel. [CML ET AL. 2001]

The complexity of LCA requires a fixed protocol for performing a LCA study. Such a protocol has been established by the International Standards Organisation (ISO) and is generally referred to as the methodological framework [ISO 14040, 14041, 14042]. Four phases are distinguished in a LCA study (see Figure 3-3). If a LCA is conducted according to the ISO standards the addressees can judge whether the results are reliable or not due to the required transparency and methodological quality of the analyses.

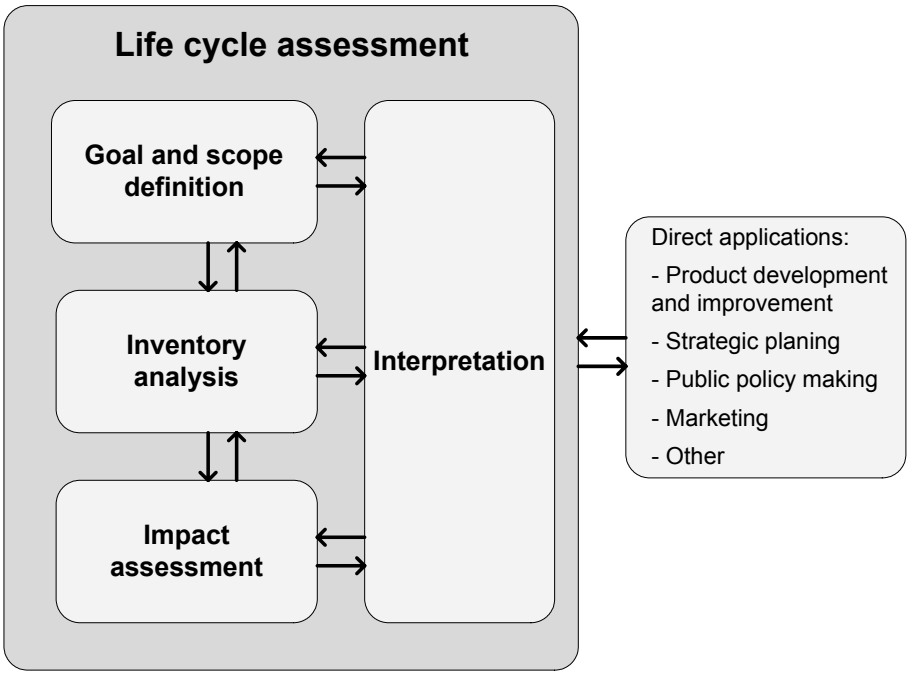


Figure 3-3: Phases of a LCA [Source: ISO 14040]

Material Flow Analysis (MFA) performed for a product is comparable to one part of the Life Cycle Assessment due to data collection and balancing. In a MFA and in a LCA it is important that the input-output balances add up so discrepancies in material flow data turn out to be evident.

In a LCA an impact assessment is performed based on the inventory analyse which comprises the data collection. All impacts at the system boundaries have to be evaluated. In the impact assessment usually the following impact categories are evaluated: Global warming potential, stratospheric ozone depletion potential, photochemical ozone formation potential, acidification and eutrophication potential. For the evaluation of surface demands, human and ecotoxicological impacts no common standards are available yet.

The main applications of LCA are:

- Identification of the origins of environmental impacts
- Identification of improvement variants of a given product, process or service
- Information for selecting a number of products with the same function
- Assistance in decision making in industry, governmental or non-governmental organisations (strategic planning, priority setting, product or process design)

The LCA methodology helps to chose the most efficient ranking and selection of waste minimisation tools. Therefore, it is advisable to guarantee the successful outcomes from waste minimisation projects [OECD 1998A].

For the evaluation of the result of a LCA the explicit question analysed is essential. On the one hand, there can be analyses evaluating individual waste treatment processes as it has been done in LCAs about the recycling of used oils, sewage sludge or biological wastes. On the other hand there are analyses concerning the whole waste management system to generally evaluate which kind of waste has the biggest overall impact on the environment. In Germany several LCA have been conducted to clarify waste economic and management questions. A LCA comparing different kinds of packaging for beverages for instance led to a discussion about the quota on returnable beverage packaging. Also the Green Dot System in Germany was analysed. This shows that LCA are used as scientific and technical background information in political decisions. LCA are also performed in industries but usually to a lesser amount due to the complexity of the analyses. BASF has for instance developed an eco-efficiency analyse based on the same ISO methodology. This shows the possibility to combine LCA with an economic analysis so that one can observe the environmental and economic impacts of a product, process or service at the same time.

The disadvantage of LCA is that it is a quite expensive instrument due to the high complexity which needs time to be conducted. A simplification of the procedure can be achieved by common life cycle data bases because the data collection is time-consuming. One has also to take into account that a single LCA itself is comparable due to similar units and assumptions. But the results of different LCA are hardly comparable due to different explicit questions, units and assumptions which can influence the results. In addition one has to note that environmental impacts can only be considered as far as they are scientifically accepted and as far as data bases exist.

4 Instruments for waste prevention and minimisation activities

4.1 External diseconomies in the field of waste management

If economic players´ activities have impacts on other market participants and their position to produce or to consume goods and, if these impacts are not regulated by the price mechanism of the market, then economists call it an externality. Any **external diseconomies** representing a disadvantage to other market participants and the public have to be borne by themselves because originators do not account for all social or environmental costs [ENDRES 1994, p.14; WEIMANN 1995, pp.30; SEITZ 2001, p.55; WEIMANN 2002, p.250]. Thus, in the field of waste disposal, costs arising by external diseconomies can be expressed by the difference between social costs, caused for example by impairment of landscape, odour nuisance, release of greenhouse gases or toxic leachate, and the private costs for waste disposal services.

Figure 4-1 illustrates these facts in an **economic equilibrium model**. The supply of disposal services for a given technology is determined by the marginal cost of disposal (mcd). As a simplification they are supposed to be constant. Furthermore, the demand curve represents the marginal benefit of disposal (mbd) for the waste holder. The line “msc” represents the marginal social cost. The market mechanism leads to point A which is not optimal in regard to social welfare since price p_0 does not reflect all the costs which are caused by the disposal. In this case external diseconomies are not considered. The so-called pareto-optimum can only be reached in point B where the price is equivalent to the marginal social cost (msc). Hence, moving from point B to point A an increase of disposal quantity from x* to x_0 results in a loss in social welfare. [CANTNER 1997, pp.177]

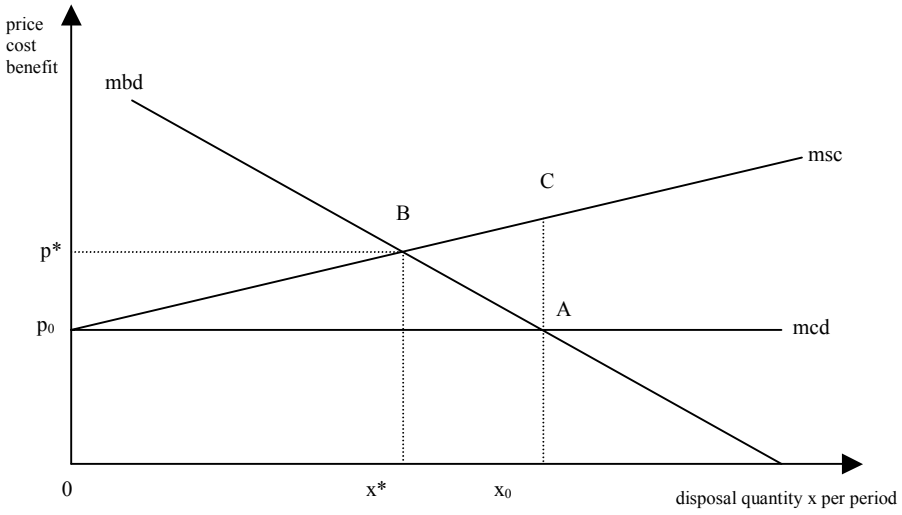


Figure 4-1: Social costs in the economic equilibrium model

To support waste prevention and minimisation, strategies to internalising external diseconomies are essential.

4.2 Internalisation strategies

Especially for public goods such as clean air or water the price mechanism of the market is not able to create an optimal allocation and usage of exhaustible resources. Therefore, the **internalisation** of external diseconomies should be the major target of modern environmental policy, which shall affect economic players in a way that the originator takes all costs (including social costs) of production respectively consumption into account corresponding to the Polluter Pays Principle [HEIGL 1989, p.317]. Indeed, there are a few severe problems which occur in connection with internalisation. For example, the question of how environmental impacts can be expressed in monetary units. Furthermore, it is not always clear who causes specific environmental impacts due to long-term and distance effects. [WICKE 1993, p.153; GÜNTHER 1994, pp.141; Cantner 1997, p.190]

Nevertheless, there is a variety of different instruments available to governments to support waste prevention and minimisation. A possible classification is given in Figure 4–2.

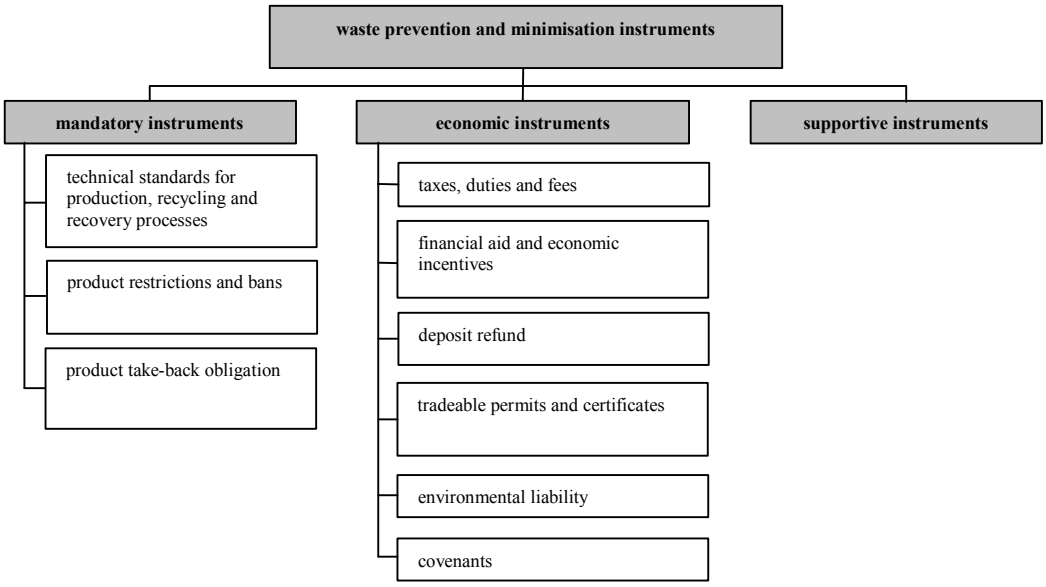


Figure 4-2: Instruments for waste prevention and minimisation

4.2.1 Mandatory instruments

The first group of instruments is affecting waste holders´ behaviour directly by **administrative regulations**. Based upon the Polluter Pays Principle and the Precautionary Principle (see chapter 3.1) commands are a common way to achieve environmental objectives since they assure a high ecological efficiency [KUHN 1990, p.737; SCHMIDT & SANDNER 1997, p.81; KLINGELHÖFER 2002, p.251]. Although regulations request that waste producers and holders must act in a predetermined way thorough control and monitoring is necessary. In this respect administrative shortfalls, possibly due to inadequate personnel resources in regulatory authorities, become a significant issue. Though regulations take effect very fast they are not appropriate to evoke technical innovations because of missing financial and administrative incentives, i.e. causers do not benefit from outperforming given regulations. Another important disadvantage is the lack of economical efficiency as every waste holder concerned has to adhere to commands. Differences between enterprises concerning their marginal costs of

waste reduction are irrelevant for this kind of instruments. [WICKE 1993, p.201; RAHMEYER 1997, p.57; ROGALL 2002, pp.216]

4.2.1.1 Technical standards for production, recycling and recovery processes

Procedural commands determine the production, recycling and recovery technology which has to be applied in specific plants. For this purpose they can define a standard that is geared towards the best available technology in use [MICHAELIS 1999, pp.21; STEVEN 1991, p.41; WICKE 1993, pp.199]. A problem in this context could be that the best available technology must be found by watching the plants concerned and thus, the definition of this standard is dependent on the information given by the plants' operators. Currently standards for the **best available technology** are elaborated on an European level for the implementation of the Integrated Pollution Prevention Control (see chapter 3.1.1). Finally, the best available technology in use is connected with the decision to invest since investments in innovative production and recycling technology are raising technological standards. Hence, the operator of a facility has no incentives to foster technological innovations as the investments are likely to increase costs. Instead of that, he will try to use the approved facilities as long as possible, on environment and public accounts [WITTMANN 1994, pp.75]. However, the purchase of innovative technologies may support more efficient production leading to advantages for the company. Nevertheless, the application of ecologically more efficient technologies in production, recycling and recovery processes can help to reach the goals of waste prevention and minimisation. In this respect especially integrated environmental technology is preferable since it stimulates the implementation of waste minimisation measures at earlier production stages and thus creates processes which are really environmentally sound.

Minimal **technical standards** for all waste recycling and recovery facilities are necessary in order to prevent the transportation of waste to cheaper plants, which often use lower level technologies. Low-quality recycling leads to the production of low-quality secondary materials which are often more expensive than the brand new raw materials they could replace. Thus, the harmonisation of technical standards is a good way to guarantee safe treatment respectively disposal of all waste streams. [OECD 1998B, p.18]. Besides, procedural commands are sometimes combined with limit values. In case of non-compliance of limit values the facility concerning can not receive any operation licence. Therefore, limit values restrict ecologically harmful activities and their rise can effect innovations in the field of environmental technology. Another consequence could be the substitution of input factors as they determine arising emissions, waste quantity and quality [MICHAELIS 1999, pp.31; WICKE 1993, pp.206]. Admittedly, the implementation of technical standards as well as the compliance of limit values for production and recycling processes can create technical and economical problems for the industry concerned. In general, standards are set for specific industrial sectors as well as for specific recycling processes, plants and production sectors.

Table 4-1 shows the main areas of application of technical standards in the surveyed OECD countries. Almost all the countries that used technical standards considered them to be an effective instrument and foresaw their intensified use in the future. Most of the countries that did not apply legally binding technical standards also did not consider them to be effective and did not foresee their greater use in the future. [OECD 1998B, p.18]

Table 4-1: Mandatory instruments

	Technical standards for production, recycling and recovery processes	Product bans	Product restrictions
Australia		n.a.	
Austria	1, 2, 3, 4	X	X
Canada		X	
Czech Republic			
Denmark		X	
Finland	[1)]	X	X
France	n.a.	n.a.	n.a.
Germany	1, 2, 3, 4	X	X
Hungary	n.a.	X	X
Italy	2, 4		
Japan	3	X	
Korea	2, 3, 4	X	X
Netherlands	n.a. [1)]	X	
New Zealand			
Norway			
Poland			
Spain			X
Switzerland	2, 3	X	X
Turkey	1, 2, 3, 4	X	X
United Kingdom	3	X	X
United States			
Total	8	12	9

1 All plants and production processes
2 Specific plants and production processes
3 Specific industrial sectors
4 Specific recycling/recovery processes

n.a.: no answer

[1)] There are no legally binding technical standards, but waste minimisation requirements are integrated into the licensing process.

4.2.1.2 Product restrictions and bans

While technical standards prescribe requirements for the process of manufacturing, **product restrictions** focus on the characteristics of goods instead. Product restrictions shall help to reduce not only the total amount of waste but also its potential impacts on the environment. Product standards in terms of input and output restrictions can help to succeed in this. They influence the composition of the product by prohibiting the use of specific raw materials and supplies which have considerable negative environmental impacts during production, usage

and/or disposal phase. Moreover, they can avoid the accumulation of harmful substances in goods in case of subsequent recycling activities. If voluntary environmental agreements have failed the threat of product restrictions may increase industries´ willingness to co-operate. Product bans can be seen as the last resort and should be used only when products are expected to cause high environmental damages.

In the European Union for example batteries, packaging and packaging waste, end-of-life vehicles as well as electrical and electronic equipment have been typically restricted for waste minimisation purposes. A typical problem of product bans and restrictions is that **free-riders** may gain economic advantage by ignoring legal regulations. Further, easy-to-use tools for controlling and monitoring restrictions are not available yet. Therefore, ecological performance measurement remains still difficult. Finally, economic impacts on industry caused by product restrictions must not be ignored. [OECD 1998B, p.19]

According to the OECD survey, eleven countries considered product restrictions and bans to be effective for waste minimisation and foresaw an increasing importance of their use in the future (see Table 4-1).

4.2.1.3 Product take-back obligations

In general **take-back obligations** aim at the realisation of closed loop systems as products do return to the manufacturers and/or distributors after usage. According to the Product Stewardship, on the one hand, take-back obligations comprise the physical receipt of used products and thus the need for establishing adequate take-back systems and, on the other hand, they comprise the waste treatment and disposal by the institution which placed the product in the market. As companies face the fact that products once sold will be returned by customers, they are likely to consider future environmental impacts along the entire value chain, i.e. product development, production, distribution, consumption and disposal and thus following the cradle-to-grave-principle. Manufacturers also have the best knowledge about the re-use and recycling options of their products.

In consideration of the **cradle-to-grave-principle** producers must predict the environmental impacts of their products already during product planning as the design phase still allows relatively easy modifications. Especially the choice of materials and the construction patterns affect the product life span as well as the dismantling and/or recycling processes. Although prolonged life spans slow down resource extraction and flows, they appear counterproductive for markets facing fast technological progress. Therefore, companies must find a balance between market and disposal options. Case by case or product by product focus is given to either longevity or short-dated products, simple dismantling or re-use of parts or modules in similar or new fields of application, or recycling of parts of the used product (i.e. feedstock or energetic recycling). The choice of materials depends on their saleability on the market for secondary raw materials. Additionally, the collection of homogeneous products shall result in type-specific waste fractions that facilitate high-end recycling processes. However, such measures could prevent the industry of sorting technology from new innovations.

When **implementing take-back obligations** some issues have to be looked at:

- First of all, it must be defined where in the value chain the take-back obligation is applied. It can be applied with the producer or with the dealer. Aiming at the producer seems to be favourable due to his knowledge regarding the product. The involvement of the distribution chain makes sense as distributors could organise an area-wide take-back system close to the market.
- Moreover, not every kind of product is appropriate to be dealt with in take-back systems. High quantities of specific waste and/or waste with severe ecological impacts justify the usage of take-back obligations, for instance used batteries, used electrical and electronic equipment, end-of-life vehicles, waste oil as well as expired pharmaceuticals.
- Furthermore, it needs to be decided whether a producer only must take back own products or even third party products. The latter possibility seems to be more convenient for customers since they can return used products to every dealer/producer. Thus, they can reduce their individual transaction costs. Unlimited and differing take-back quantities and consequently non-controllable disposal costs may cause unequal financial burdens for the companies in charge. To attenuate this potential distortion of competition the number of used products that have to be taken back by a company could be limited to the number of products sold in a reference period.
- Moreover, it is disputable whether a producer has to take back products that had been sold prior to the take-back obligation coming into force. A similar question occurs if the company concerned goes bankrupt. Who will pay for taking back the used products and their disposal? In such a case most likely the public has to stand in FISCHER [2001, pp.344].

Table 4-2 illustrates in which companies surveyed product take-back and deposit refund schemes are applied. [OECD 1998B, p.20]

Initially take-back obligations cause **extra costs for producers/dealers** since taking back, logistic, storage, disposal, documentation and verification management represent additional efforts. Whether take-back obligations end up profitable or lossy has to be calculated for every single product group. However, the establishment of additional disposal infrastructures parallel to the existing waste management system is supposed to cause costs that cannot be compensated by ecological advantages. Of course, interference in existing waste management structures could also lead to unpredictable effects and damages.

The **success of take-back systems** is highly dependent on the customers´ motivation to bring back used products respectively waste. In order to reach high return rates an obligation to return could be established. Consumers would be obliged to bring back used products instead of littering them or disposing them together with their household waste. However, return obligations are only supported by legal penalty pay but do not make use of market-relevant incentives. Therefore, the 6-Level-Model would categorize such waste on level 3 unless a deposit-refund scheme is applied (see chapter 2.2).

Table 4-2: Product take-back and deposit refund

	Product take-back	Deposit refund
Australia		X
Austria	X	X
Canada	X	X
Czech Republic		
Denmark	X	X
Finland	X	X
France	n.a.	n.a.
Germany	X	X
Hungary	n.a.	X
Italy		
Japan	X	X
Korea	X	X
Netherlands	X	
New Zealand		
Norway		
Poland		
Spain	X	
Switzerland	X	X
Turkey	X	X
United Kingdom	X	X
United States		X
Total	**12**	**13**

n.a.: no answer

4.2.2 Economic instruments

In the last few years it became more and more obvious that waste legislation in some countries is over-regulated and that governments are swamped with managing every sector of environmental policy in detail. On the other hand, market failure requires interventions by the government in order to approach sustainable development. New **economical instruments** that make use of the 'free market' mechanism shall bring a solution for the future. These instruments do not prescribe when and how the waste originators have to act environmentally friendly. Instead, they assign incentives to award a change in behaviour [KLINGELHÖFER 2002, p.251]. Principally based on the Polluter Pays Principle (see chapter 3.1) these instruments seek to induce economic players to design their goods ecologically sound in order to reduce waste during production, usage and disposal. Compared to administrative regulations

new economical instruments discriminate products which are harmful to the environment by raising their price, for instance, by charges or taxes. Hence, external diseconomies can be (at least partially) internalised. In order to cut their costs, originators are keen to reduce environmental pollution beyond the standard which is fixed by commands [ENDRES 1994, p.135pp.; RAHMEYER 1997, p.54]. In addition, economical efficiency on a high level is provided because originators can decide independently which measures they take. Thus, originators can act cost optimal according to the individual marginal cost of waste avoidance and a given environmental quality can be achieved with lower economic expenses. Financial incentives may foster innovations of environmental technologies as long as they exceed the marginal costs of avoidance [KNORRING 1997, p.24].

Free market instruments, however, are not always the best choice because their effects can be incalculable and/or temporally delayed (especially with 'soft' instruments like covenants). Particularly, in case of severe environmental threats they do not seem to be as reliable and effective as administrative regulations. On account of this, new economical instruments should be implemented for precautionary measures rather than for defensive measures against immanent dangers [WICKE 1993, p.406; MICHAELIS 1999, p.23].

4.2.2.1 Basic reflections on costs and benefits of recycling versus disposal activities

The assessment of sustainable activities in regard to '**economic reasonability'** underlines the necessity of identifying and taking into account the relevant monetary costs and benefits of recycling versus disposal measures. As Figure 4-3 illustrates the differentiation between goods (I), waste to be recycled (II) and waste to be disposed (III) is determined by the respective costs. Whereas goods are characterised by a positive revenue, waste has a negative value. This idea is represented by the vertical revenue/expenses line in Figure 4-3. The diagonal line shows the costs corresponding to the value of the material. The borderline between recycling and disposal is marked by line 'A'. From there on the waste holder logically chooses disposal as it is economically advantageous. Consequently, the waste holder diverges from the original diagonal sloping cost-line. The economic control of recycling activities (II) is accomplished through the waste holder's intention to avoid higher disposal fees (III). Recycling of waste only seems reasonable as long as recycling costs are below disposal costs. Similar to the criteria of 'ecological advantage' (see chapter 3.1.14) recycling activities in terms of 'economic reasonability' are not sensible at any price.

The reason for recycling activities is rather driven by a simple cost calculation than by a strong desire for utilizing residual waste. From an economic point of view, therefore, **recycling is not a goal but an option**. The decision is based on an opportunity cost calculation. Accordingly, the prices for disposal services (currently mainly determined by regulations of public fees) represent the central decision determinant for waste holders to seek for recycling services. They state the price ceiling for recycling activities. Rising disposal costs would induce an increasing demand for recycling services and vice versa. If the price-driven decision path mirrors the ecological reality correctly, i.e. if ecological damages are completely internalised, the price mechanism leads to an optimal differentiation of goods into the three areas described in Figure 4-3. When recycling is superior to disposal then the waste also achieves a positive **net ecological impact** when being recycled (see chapter 3.1.14). That means that the price difference between recycling services and corresponding disposal also quantifies the ecological advantage. The major deficiency in assessing the economic reasonability, therefore, is obviously represented by incorrect or unknown prices for disposal services that allow for both a market- and an eco-equilibrium. [BAUM & WAGNER 2000, pp.15]

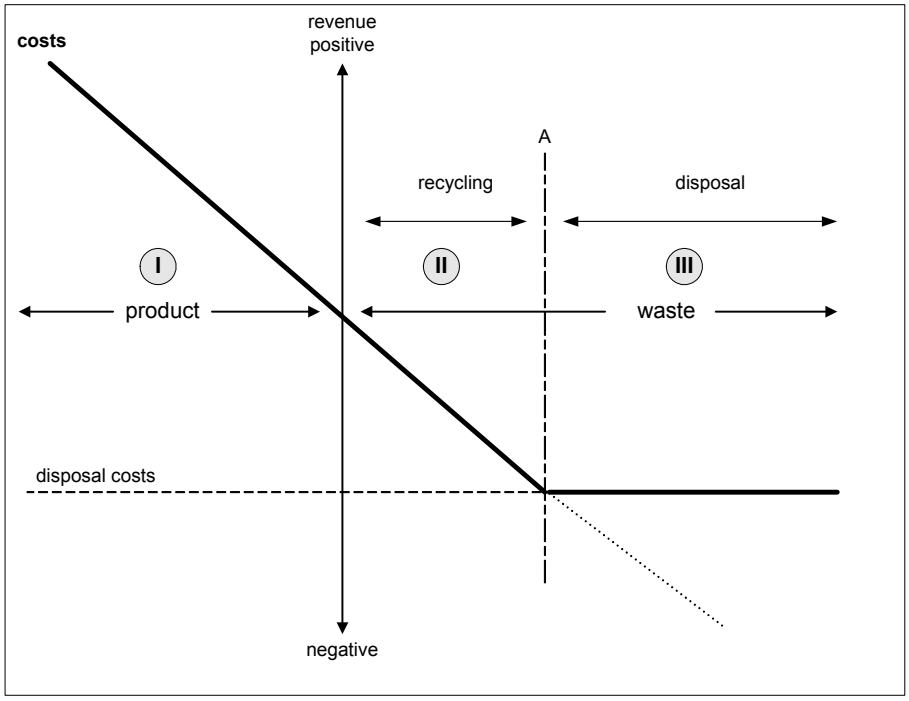


Figure 4-3: Individual economic reasoning for goods respective wastes [BAUM & WAGNER 2000]

Subsequently, we will present a detailed overview on instruments concerning environmentally orientated taxes, duties and fees, financial aid and economic incentives, tradeable permits and certificates as well as voluntary approaches as they are implemented by various countries.

4.2.2.2 Taxes, duties and fees

These instruments try to induce waste originators to internalise social costs by setting prices for environmental harmful activities and/or products which try to reflect the real costs of environmental impacts [RAHMEYER 1997, p.52; SCHMIDT & SANDNER 1997, p.82; WICKE 1993, p.395]. For the application of these instruments it is important to determine the basic approach which can either be based on input factors or products respectively undesired outputs.

In the first case the price for specific materials and energy can be increased by **taxes** which leads to higher expenses for the companies purchasing. This can provide an incentive for the firms to reduce the usage of these specific resources and vary their input factors for the benefit of environmentally sound ones. Moreover, the development of new and more effective technologies in production can help to enhance the resource productivity [BINDER 2002, pp.838]. Further, ecological taxes on products are applied if the production, consumption and/or disposal of specific goods is connected with negative environmental impacts, for example, waste intensive products such as packaging. In these cases the tax load depends on the environmental impacts caused by the product during its life cycle. As a matter of principle a company concerned can react by reducing the harmfulness of its products by input substitution and/or process variation.

In both cases ecological taxes, duties and fees are intended to raise the prices for environmentally harmful in- and outputs in order to change the demand to the benefit of environmentally sound products and processes [KUHN 1990, pp.739]. Therefore, the financial burden for

every company depends on both the quality and quantity of the environmental damages caused. Figure 4–6 illustrates when it is worthwhile for polluters either to take measures for reducing the environmental impacts or to pay the charged taxes.

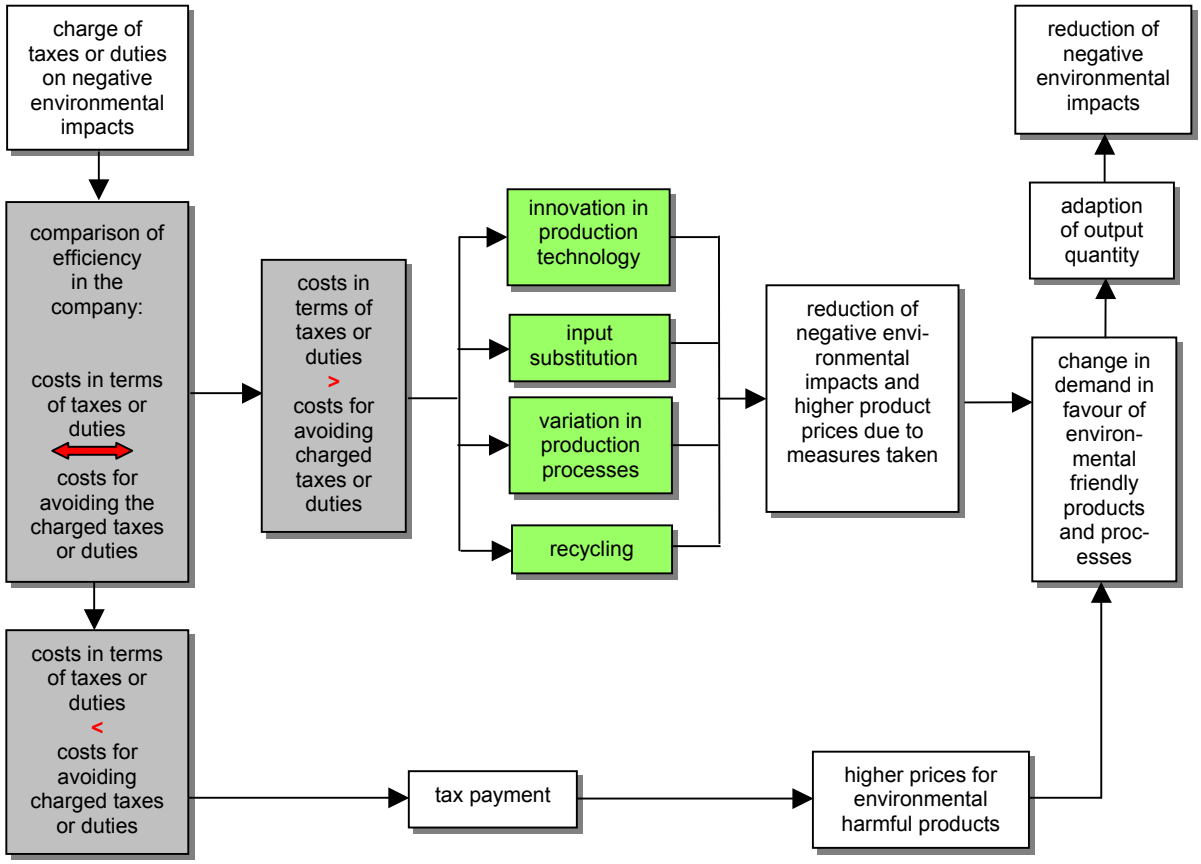


Figure 4-4: Intended functional chain of taxes and duties

Taxes and duties do not prescribe how and to what extend the polluter has to avoid impacts on the environment [TERHART 1986, p.403]. Companies which can reduce their impacts cheap and easily will reach a higher degree of reduction than others. Anyway, the latter ones have to bear additional expenses in terms of higher taxes. Thus, an improvement in environmental quality can be reached cost efficiently due to the setting of financial incentives. Admittedly, the practical implementation is difficult since policy makers do not know in advance the tax load which is necessary to reach a specific environmental quality. In addition, financially motivated reactions which result from taxes or duties are unpredictable and thus insecure. To guarantee at least a minimum standard for environmental protection the combination of taxes and technical standards respectively product restrictions seems to be appropriate [MICHAELIS 1999, pp.40].

According to the OECD survey, economic instruments are mainly applied in the form of taxes and duties for waste treatment and landfilling. But also taxes/duties on raw materials, resources and energy as well as on waste-intensive products are widespread. All the countries considered taxes and duties to be effective waste minimisation instruments and expect more intensive use in the future. (see Table 4-3). [OECD 1998B, p.23]

4.2.2.3 Financial aid and economic incentives

While taxes, duties and fees punish originators of negative environmental impacts, **financial aid and economic incentives** shall award environmentally sound behaviour [RAUSCHENBERGER 2001, p.40]. An incremental accentuation of technical standards and restrictions is often associated with an increase in investment needs [MOOREN et al. 1991, p.267]. To alleviate this additional cost burden and to improve the efficiency of environmental protection measures aids in the form of subsidies, low-interest credits, special depreciations, cost-free consultancy services and sureties can be offered from policy makers, ideally financed by public revenues in form of environmental charges.

An **advantage of these instruments** is the promotion of the achievement of desired outcomes concerning waste prevention and minimisation targets. Further, private investments into environmental technology may be stimulated and supported. When implementing such support programmes special attention should be directed to the promotion of integrated technologies. Furthermore, it should be noticed that rigid environmental standards and restrictions geared to the state-of-the-art can inhibit technological innovations (see chapter 4.2.1.1). [WICKE et al. 1993, pp.324]

The **main areas of application** of financial aid and economic incentives in the countries surveyed are shown in Table 4-3. Almost all countries considered financial aid to be an effective instrument and some foresaw increased use in the future. Others were considering replacing subsidies with measures based on the Polluter Pays Principle.

Table 4-3: Economic instruments

	Taxes and duties			**Financial aid and economic incentives**					
	Areas of application			Areas of application					
	1	2	3	A	B	C	D	E	F
Australia			X	X	X		X	X	
Austria	X		X	X	X	X	X	X	X
Canada		X	X	X	X	X	X	X	X
Czech Republic	X		X	X	X	X	X	X	X
Denmark	X	X	X	X	X	X	X	X	X
Finland	X	X	X	X	X	X	X	X	X
France	n.a.	n.a.	X	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.
Germany		X	X	X	X	X		X	X
Hungary	n.a.	X	n.a.	n.a.	n.a.	X	n.a.	n.a.	n.a.
Italy	X		X	X	X		n.a.	X	
Japan				X	X	X	X	X	X
Korea	X	X		X	X	X		X	
Netherlands	X		X	X	X		X	X	
New Zealand				X	n.a.	n.a.	X	n.a.	X
Norway									
Poland			X	X	X	X	X	X	
Spain				X	X	X	X	X	X
Switzerland			X	X	X		X		X
Turkey			X						
United Kingdom			X	X	X		X	X	X
United States				X	X	X	X	X	X
Total	**7**	**6**	**14**	**17**	**16**	**12**	**14**	**15**	**12**

1 Raw materials, resources or energy
2 Waste-intensive products
3 Treatment and landfilling
n.a.: no answer

A Research and development on waste prevention/recovery technologies
B Pilot tests
C Investments in low-waste production/products
D Consultancy services
E Innovative solid waste recovery technologies
F Eco-balances, life-cycle assessments, eco-auditing

4.2.2.4 Deposit refund

The combination of take-back obligations (see chapter 4.2.1.3) with **deposit-refund schemes** is more likely to foster closed loop systems than only return obligations. That is because deposit-refund obligations set an economic incentive for customers by increasing

the value of the used product/waste by the amount of the deposit. In the 6-Level-Model such deposits grade up waste from level 3 to level 2 (see chapter 2.2). Consequently, deposit-refund schemes may help to reduce the littering problem. People want to receive their deposit or even pick up littered waste in order to make a windfall profit.

Similarly, the success of a **deposit-refund scheme** is mainly determined by its **implementation**. The deposit amount is affecting customers´ opportunity cost calculation and thus their motivation to return waste. In general, a high deposit tends to motivate people to return waste to the producer or dealer. But if the deposit is exceeding the value of the product it would be lucrative to produce waste. Apart of financial incentives also convenience aspects and idealistic motives can play an important role for motivation. Additionally, the organisation of deposit-refund systems should be planned carefully. If the customer shall obtain the deposit from any dealer of a certain branch a clearing system is essential as deposits received and deposits refunded will differ in a certain period of time. Any surplus deposits which are not claimed by customers have to be fairly allocated by the clearing house as so-called windfall profits. Also interest profits for the period between deposit receipt and payback reduce the costs for operating a deposit-refund system.

Deposit-refund schemes seem to be **appropriate for more complex products** that may have extensive environmental impacts like, for instance, cars (as realised in Sweden) or electronic equipment like refrigerators (as realised in Austria). In this regard it must be considered whether the deposit is always refunded as total amount or **dependent on the final condition of the product**. Broken or incomplete products may not qualify for a full reimbursement of the deposit. Since the refunded amount of money then becomes influenceable by both parties involved, i.e. the recipient and the disposer, it might create a new marketing tool. Just imagine a car dealer who offers full reimbursement irrespective of the condition of the car but bounded, for instance, to the purchase of a new car. This would probably represent a unique selling proposition.

4.2.2.5 Tradeable permits and certificates

In 1994 the European Commission enacted the Directive on Packaging and Packaging Waste 94/62/EG. This Directive aims to harmonise national measures in order to prevent or reduce the impact of packaging and packaging waste on the environment and to ensure the functioning of the internal market. It contains provisions on the prevention of packaging waste, on the re-use of packaging and on the recovery and recycling of packaging waste. Like every country in the European Union, Germany had to transfer this directive into German law. Over the years defects of the German Ordinance on the Avoidance and Recovery of Packaging Waste, high and inflexible recovery rates, extremely high costs due to the ambitious recovery rates and the quasi-monopoly position of the Green Dot System as well as the pure focus on waste recovery instead of waste prevention measures led to the question of alternative solutions. Other European countries chose different ways to implement the respective EU directive: The Netherlands chose a co-operative approach whereas in Great Britain the Packaging Recovery Notes (PRN) system based on tradeable licences was established [Ewers et al. 2002, pp.2]. Subsequently, the mode of operation and basic parameters of the different approaches which should be noticed in case of implementation will be explained.

The **system of tradeable permits** describes the idea that the government stipulates a maximum amount of emission for a specific harmful substance in a well-defined area. If en-

terprises cannot avoid this pollutant they have to buy licences which certify the right to cause pollution equal to the purchased licence, whereby each licence represents a fraction of the total quantity permitted. In case of packaging waste licences certify the right to distribute a certain amount of non-reusable or ecologically disadvantageous packaging [BAUM et al. 2000, p.81]. The target of so-called 'cap and trade' systems is to limit the total amount of packaging and thus their environmental impact. After having distributed a pre-determined number of licences to the current polluters they can be traded on the market and the price mechanism will find an optimal allocation. In contrary, the objective of the British PRN system is to achieve certain recovery rates given by the European Union ('baseline and credit' system). To point out the difference between these two systems: in 'cap and trade' approaches the number of tradeable permits is fixed ex ante, in 'baseline and trade' systems it can be ascertained ex post. Apart of the waste sector tradeable permits´ application is also discussed for primary energy sources, air, water and land area, e.g. for every usage of natural resources. As an example, the European Union decided to introduce a carbon dioxide emission trading system by 2005 to implement the United Nations Framework Convention on Climate Change agreed upon 1995 in Kyoto.

In order to reach determined environmental objectives licence systems allow every polluter who is bound to buy licences a **maximum of decision autonomy**. If an enterprise utilises ecological resources that are controlled by licence systems it has to purchase the corresponding number of licences at the market. If it reduces its consumption the enterprise can sell licences that are not required any longer and thus finance its avoidance activities. Consequently, by stipulating the maximum consumption of ecological resources instead of influencing their prices tradeable permits support an accurate attainment of environmental goals (ecological perspective). For a company it is profitable to sell their licences when the selling price is higher than its marginal costs of reduction. Accordingly, a potential polluter pays that price at the market if its marginal costs of reduction are higher. Therefore, environmental protection investments are made by market players being able to act cost-efficiently (economical perspective). In the long run the environmental agency has to keep the licence price high in order to foster technological progress. Innovative technologies could lead to a decline in demand for licences and thus to decreasing market prices that diminish the incentives to induce progress [BAUM et al. 2000, pp.128]. Incentives usually remain if maximum limits are being tightened from time to time.

These positive effects face **configuration problems** that have to be noticed in view of a successful implementation in practice [FEDERAL ENVIRONMENTAL AGENCY 1997, pp.127; SPRENGER 1999, pp.236; SALMONS 2002, pp.193]. First of all, tradeable permits according to a 'cap and trade' system require the stipulation of a maximum amount of emission. That can be a complex and long-winded political process since numerous stakeholders and lobbyists are involved. Especially a fast and rigorous realisation could evoke financial burdens for enterprises and therefore, a lack of acceptance. That is why an implementation step by step seems to be more promising. In Great Britain for example, small enterprises have been excluded from the PRN system in the beginning. Then the scope and the number of obliged companies as well as recovery rates have been gradually raised. As a result there are higher administrative expenses for licence distribution, monitoring and control. However, an increasing number of suppliers and customers strengthens the efficiency of the market and reduces respective transaction costs. Moreover, early expiry dates of the regulation could facilitate adjustment processes in regard to the maximum amount of emissions. On the other hand, an extended validity period could improve planning reliability and thus reduce the risk of misinvestment. However, open-end or long-term solutions bear the risk of disrupted competition. If

companies purchase licences far beyond their own needs current competitors might run short in their liberty of action. The more a competitor depends on a certain resource for production purposes the more effective such measures become. Hence, the market is strategically influenced by an artificial lack of certificates or just increased by unaffordable prices.

The **procedure of issuance** also can influence the reliability of planning. Particularly a free licence allocation (grandfathering) based on historical market shares is expected to be easily enforceable as it respects the status quo. Other distribution concepts, for example auctions or fixed-price-selling, are likely to cause high costs for enterprises involved. Therefore, financially strong companies could try to accumulate licences on purpose in order to displace rivals from the market. This risk probably could be avoided by limiting the validity periods. Finally, tradeable permits´ efficiency and therefore their success depend on a continuous monitoring, control and sanction system [CANSIER 1998, pp.99; BAUM et al. 2000, pp.82].

A direct comparison between the British and the German waste management system is limited to certain conditions. The German Ordinance on the Avoidance and Recovery of Packaging Waste stipulates higher recovery rates than the corresponding EU directive. One major target of implementing the PRN system in Great Britain was to achieve the EU rates in a cost-effective way. Therefore, recovery activities in Great Britain emphasize packaging that are easy to collect and to sort. In Germany a complex and expensive system is collecting even the smallest packaging from all over the country regardless of a scientifically proved ecological value. Consequently, the German packaging waste recovery system operates on annual expenses amounting to approximately 2.0 billion Euro which equals about 22 Euro per capita. The British system in comparison operates at 0.1 billion Euro respectively 2 Euro per capita [EWERS et al. 2002, pp.19].

In order to reach a high (nearly 100%) recovery rate regardless of rising marginal costs a ‘command and control’ structure like DSD appears preferable. Free-market instruments, on the other hand, tend to be appropriate to realise moderate (far below 100%) recovery rates like PRN at lower marginal costs and thus save financial means as pointed out in Figure 4-5.

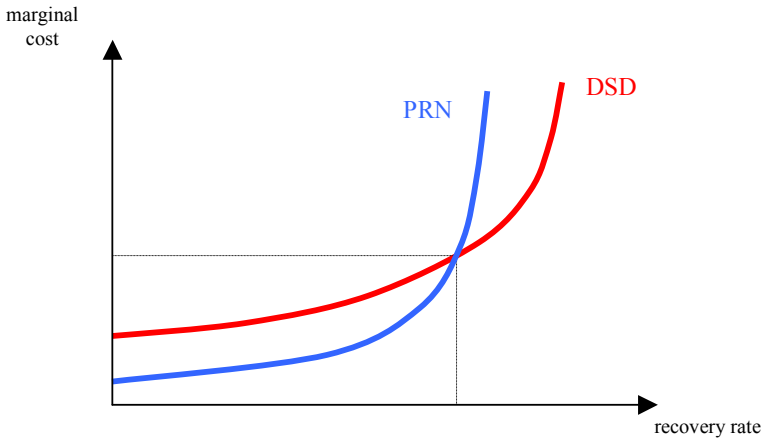


Figure 4-5: Comparison of Green Dot System and Packaging Recovery Notes

As indicated before, tradeable certificates could also be of particular importance for saving primary natural resources (e.g. oil, gas, coal, etc.). As their quantitative availability on earth is limited it appears favourable to also stipulate a cap for primary natural resources and exercise control by tradeable certificates. If this is realised on a virtually global basis that model

could help to improve the resource productivity index by regulating the inputs. However, primary natural resources are not considered on a large scale yet as attention is mainly paid to outputs.

4.2.2.6 Environmental liability

Another promising approach to intensify the self-interest of companies in regard to waste prevention and minimisation could be an adequate design of the **environmental liability**. When producers originate environmental damages, according to the Polluter Pays Principle (see chapter 3.1), they are responsible for the effects and have to bear all the costs. Hence, they should pay special attention not only to their production processes but also to their products if they want to prevent environmental risks and thus compensation payments.

Basically, in terms of environmental liability **two strategies** can be distinguished. Firstly, the liability is linked with the **technological standard** (i.e. best available technology) used in the production process. In this case compensation payments may occur if the producer has not complied with this standard. Consequently, the impulse to fulfil given obligations is very strong. Secondly, the focus could be set on the **responsibility of manufacturers** and importers to produce and distribute products in consideration of maximal waste reduction during production and use as well as environmentally sound recycling and disposal possibilities, which is expressed by the Product Stewardship (see chapter 3.1.2). Therefore, Product Stewardship aims at the internalisation of recycling and recovery costs. It particularly calls for the development, production and distribution of products which allow multiple use, which are technically long-living and which are suitable for environmentally sound recycling and disposal procedures. It prioritises the input of recycled waste or secondary raw materials in production processes, it requests labelling of finished goods that contain harmful substances, it requires instructions concerning the possibilities and/or obligations to return, re-use or recycle products and finally it constitutes the obligation to take back both goods and ‘bads’, i.e. waste.

In this regard, especially for small and medium-sized enterprises, a problem could be the imminent danger of bankruptcy due to high compensation claims. An environmental liability insurance could help to avoid this danger. If the insurance rate is connected to the potential danger of the production process respectively product the companies have an incentive to prevent or minimise the production of hazardous waste. [WICKE 1993, pp.221]

4.2.2.7 Covenants

Based on the Cooperation Principle (see chapter 3.1) **covenants** contain agreements stipulated between the environmental authority and companies to refrain from environmentally harmful or to enforce ecologically sound activities (e.g. reduction of packaging materials, abandonment of environmentally harmful materials). The motivation for such agreements can be voluntary but in the majority of cases it is the threat of regulations which galvanise firms into covenants. [MÜLLER-CHRIST 2001, p.99]

More and more, environmental protection agreements complement or replace other environmental instruments like regulations, taxes or tradeable permits. Reasons are – among other things – the relatively high acceptability to the companies concerned. They are free in their decision how to achieve the agreed environmental goals and thus they will choose a cost effective way. Furthermore, no long-lasting legislation processes are necessary due to the abdication of governmental measures. Also the decreased number of regulations can be

a positive consequence of environmental protection agreements between authorities and polluters. Nevertheless, sometimes firms agree to the covenants with the intent to default because they try to retard governmental measures in the form of restrictions (procrastination effect). Accordingly, the enforcement of voluntary agreements is unsure when the imposition of sanctions is improbable respectively the sanctions are too weak. In this context, also the free-rider problem becomes inevitable. Hence, high costs for necessary monitoring and execution can over-compensate covenants´ advantages in respect of cost efficiency. [BENDER et al. 1995, p.29; Koch 2002, p.122; MÜLLER-CHRIST 2001, p.101; WICKE 1993, pp.268]

Otherwise, the costs for monitoring will decrease if the number of actors involved is manageable. Thus, the environmental authority shall not conclude the agreement with single companies but with a competent supervisory organisation. Besides, a transparent and stipulate definition of goals and sanctions can help to design a believable threat for the enforcement of covenants. Companies will fulfil the agreements when their costs for compliance are lower than their costs in case of non-performance in terms of penalties, restrictions or loss of image. Finally, the effort of covenants depends to a great extend on the flanking composition of financial incentives and legal measures. [MÜLLER-CHRIST 2001, pp.100]

4.2.3 Supportive instruments

In addition, there are various other instruments which can support waste prevention and minimisation efforts like environmental management systems (see chapter 3.1.8), environmental education and information, environmental reporting or eco-labelling.

Table 4-4: Instrument mixes

	Mandatory instruments				**Economic instruments**				**Supportive instrument**	
	Technical standards		Restrictions and bans		Taxes, duties		Financial aid and economic incentives		Eco-labelling	
	Yes	No	Yes	No	Yes	No	Yes	No	Yes	No
Australia		X	X		X		X		X	
Austria	X		X		X		X		X	
Canada		X	X		X		X		X	
Czech Republic		X		X	X		X		X	
Denmark		X	X		X		X		X	
Finland		X	X		X		X		X	
France	n.a.	n.a.	n.a.	n.a.	X		n.a.	n.a.	n.a.	
Germany	X		X		X		X		X	
Hungary	n.a.	n.a.	X		X		X		X	
Italy	X			X	X		X		X	
Japan	X		X			X	X		X	
Korea	X		X		X		X		X	
Netherlands		X	X		X		X		n.a.	
New Zealand		X		X		X	X		X	
Norway	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	n.a.	X	
Poland		X		X	X		X			X
Spain		X	X			X	X			X
Switzerland	X		X		X		X			X
Turkey	X		X		X			X	X	
United Kingdom	X		X		X		X		X	
United States		X	X			X	X		X	
Total	**8**	**10**	**15**	**4**	**16**	**4**	**18**	**1**	**16**	**3**

n.a.: no answer

Eco-labelling is a voluntary approach of environmental performance certification. This kind of labels show overall environmental preference of a product or service within a specific product/service category based on life cycle considerations, i.e. environmental impacts not only in the research and development, production, distribution and consumption phase will be considered but also in the disposal phase. Eco-labels can be divided into company or branch specific, national (e.g. Canada – Ecologo, Japan – Eco-Mark, Germany – Blue Angel) as well as international (e.g. Finland, Sweden, Denmark and Norway – Nordic Swan, European Union – European Eco-Label) marks. [FEDERAL MINISTRY FOR THE ENVIRONMENT, NATURE CONSERVATION AND NUCLEAR SAFETY, FEDERAL ENVIRONMENTAL AGENCY 2001, pp.281] A large variety of different eco-labels could confuse consumers due to the fact that they do not know about the relevant differences in detail. Therefore, it is appreciable to limit the amount of different labels.

Eco-labelling systems had been initiated in most countries which have been analysed within the scope of the OECD study (see Table 4-4). But the number of products and services that had been awarded an eco-label in each country differed considerably, although this instrument was considered to support waste prevention strategies. Experiences show that products which had been awarded an eco-label usually gained market advantage. But the measurable contribution of eco-labelling to waste prevention and minimisation might be rather small. [OECD 1998B, p.26]

4.3 Conclusion

Table 4-4 shows instruments for waste prevention and minimisation being used in many different combinations. Therefore, the comparison of countries in regard to the effectiveness of their environmental policy pursued is quite difficult. However, the most effective outcome is expected to be achieved by the combined application of means. Along with country-specific conditions such as technological, social, economic and cultural factors, the following points should be kept in mind for the implementation of waste prevention and minimisation instruments:

- **Mandatory instruments** in form of minimum technical standards may help to foster the competitiveness of secondary materials and to eliminate free-riders. But a poor enforcement of these instruments can reduce their ecological effectiveness. Moreover, the early information of groups targeted by new legislation could increase their acceptance since they would have more time for searching and implementing appropriate solutions.
- **Economic instruments** shall help to achieve environmental targets as cost effective as possible. For these purposes they foster the economic interest of waste generators to prevent and minimise waste generation. Nevertheless, technical regulations should be additionally applied since they guarantee minimum standards to avoid negative impacts on environment and human health. Although experiences have shown that voluntary environmental agreements can lead to positive outcomes, in case of non-compliance a strong possibility that stringent legislation may come into force, could support the enforcement.

Fundamental for a successful implementation of these mandatory and economic instruments is the awareness of people. This is due to the fact that not only industry directly concerned by these instruments but also consumers and their behaviour decide about the result of the measures. Therefore, it is essential to perform awareness campaigns including among other

things education at schools and universities, media activities (spots in TV, radio, newspaper or bills), events, information documents and newsletters. Especially in developing countries and in countries with economies in transition it is important to rise the awareness of the public and the industry because up to now more urgent problems are in the foreground.

As there is no clear overall preference whether mandatory or economic measures should be used, there could be further exploration of the conditions under which both approaches are effective. Also the exploration of new and innovative instruments (e.g. tradeable permits and certificates) could help to find ecologically and economically efficient solutions. Finally, also the effectiveness of different policy mixes could be interesting and helpful for a more detailed analysis.

Annex 1 gives an exemplary overview on instruments concerning environmentally orientated taxes, fees and charges, deposit refund systems, environmentally motivated subsidies as well as voluntary approaches as they are implemented by various countries. [OECD & EEA 2003].

5 The role of important groups

5.1 Politics

Many of the **instruments** described in chapter 4 which can be applied in the context of waste prevention and minimisation can be or have to be initiated and decided by politics. By the choice or the combination of different instruments politics determine the scope of action and the scope for flexibility for stakeholders, e.g. supporting new technologies or rigidity due to new limits. They should pay attention to avoid confusion, e.g. when there are too many different eco-labels irritating the consumer.

Beside the choice of instruments for the national or regional actions it is also very important especially for developing countries and countries with economies in transition, that the country itself is **stable** concerning the political, cultural and economic aspects. In general, companies appreciate long-term specifications for reliable planning and subsequently investments.

In order to raise **public awareness** politics can emphasise these topics. The different parties can support this discussion. It is also important that awareness programmes are initiated, including training and education activities.

Public investment should be in line with waste prevention and minimisation and thus be a good example for other stakeholders.

Politics can stimulate the **co-operation** on municipal, regional or national level by founding and supporting initiatives (see chapter 3.1.6). These initiatives aim at the co-operation of different actors to use synergetic effects.

Not only national governments but also **communes** play a decisive role. They need to implement resolutions of governments and also the sustainable development. They can also initiate activities in which different local stakeholders are involved.

Politics should take care to **harmonise** definitions. They are responsible to implement international agreements into national laws. They should also support the development of comparable indicators and further provide the necessary data. This includes also the transfer of information. They should also analyse the methods and concepts of other nations or regions. For instance, a study was carried out in order of the USA to check the potential for learning from Europe [ECOLOGIC 2003].

Especially in developing countries and in countries with economies in transition politics should envisage to introduce **regulations** concerning waste management and waste prevention respectively minimisation. While introducing new regulations all stakeholders should be integrated in the process of the development of regulations.

In this context also the **courts** have to be mentioned since they are responsible for the interpretation of laws. Therefore, they create facts and defaults, for instance, in clarifying the precise definition of waste.

5.2 Companies, businesses and institutions

Companies and their associations are crucial in determining waste prevention or minimisation. Their role is important for the preparation of political decisions and for the implementation of measures.

Industry uses their **lobby** in order to influence waste related legislation. Lobbying is done by industrial associations or single large companies. Therefore, they can influence regulations, the choice of instruments or their form. Their point of view is often taken into account during legislative processes. Thus they are, for instance, invited to draft implementation plans or to comment on them. There are special consultative procedures in some countries. To avoid mandatory instruments or direct regulations, e.g. laws with strict limits industry sometimes offers voluntary agreements, e.g. on the take-back or recycling of products such as end-of-use vehicles or waste tyres or programmes for certain waste streams. In regard to economic instruments industry's attitude depends on whether these instruments take the form of financial aid or of taxes and duties.

For the **implementation** of waste prevention or minimisation measures industry can either fulfil only the necessary regulations given by law or they can achieve more waste prevention and minimisation by realising concepts mentioned in chapter 3 or by participating in pilot activities. In the worst case they can oppose regulations or voluntary agreements to gain competitive advantages or they. For the implementation in industry incentives are necessary. Motivating drivers can either be financial or advantage in image, advantage in competition or simplification of permitting.

Companies can actively perform **research** or support research at institutes to develop new technologies for preventing waste during manufacturing processes, redesign of products for higher quality and durability, recycling of wastes or reducing packaging materials. They can also promote products' re-use and repair by offering services for renting, loaning, leasing, repairing.

Industry further has the possibility to actively promote a **transfer** of know-how and technology, advertise environmentally sound products and support public awareness campaigns or they can take back certain wastes or organise the take-back systems.

When companies have developed new technologies for preventing or minimising waste it is always a delicate matter of **transferring** the technology to other regions or countries. Each company has to be ensured that it doesn't lose its know-how by transferring it but that the developing costs and some profit will return. A possibility is to have a patent on the technology.

Companies can also provide **consultancy** including qualifying and educating people in charge and supporting information for the implementing of environmental management systems. This is especially important to transfer certain know-how or technologies because people are needed on site for maintenance of the technology or measure.

Businesses and institutions can develop **standards** for e.g. encouraging reduced volume, durability and re-use of purchased products; develop waste prevention requirements for internal operations.

5.3 Public opinion

Public opinion affects the **behaviour** of consumers. Buying patterns in turn strongly influence the market system of supply and demand. Depending on the demand industry increases production. If waste prevention and minimisation is an important topic in public opinion and therefore in public discussions, companies will more easily spend money or effort in technologies or concepts leading into this direction because they will have an image gain.

People are requested to **participate** in separate collection systems (e.g. organic waste, paper, glass, plastic, metal, residual, etc.) or in take-back of products so that they can enter the recycling process. Consumers and private households can boycott waste prevention and minimisation measures by giving insufficient support to separate collection systems or take-back activities, by dumping household waste illegally due to unpopular landfill disposal fees, by rejecting user-pays programmes or by continuing to buy over-packaged goods.

Consumer associations can play a role in policy aspects as described for industries. But the influence of the consumer associations are generally smaller.

A single person has only a small **influence** but if many people behave equally they can affect something. A successful example from another area was the Brent Spar Oil platform belonging to the company Shell which should have been dumped in the North Sea in 1995. Due to great protest actions initiated from NGOs and thus mobilised consumers who boycotted Shell petrol stations Shell did not dump the platform but did dispose it at land.

To get to know the public opinion concerning the significance of environmental protection there are parameters as the environmental index which can be collected by representative **surveys**. If the public awareness of environmental aspects is low, this is a sign that awareness campaigns are necessary.

Not only the media has an important influence on the public opinion but also politics can influence it by emphasising certain topics. These aspects can be used for essential **awareness campaigns** including among other things education at schools and at universities, media activities (spots in TV, radio or bills).

5.4 Social networks, organisations, initiatives, etc.

Each person is influenced by its ambience. This is the reason for the influence of the **family, clubs, parishes, cliques, neighbourhood and colleagues** on the attitude of individuals. Within these groups it is important that people give a good example in behaviour so that others can learn from them. Thus individuals and communities can promote increased waste prevention through changes in personal lifestyle including selective product purchasing, product re-use, decreased consumption. They can also give information to others persuading them to follow their example. So they can increase awareness. In the family one can learn from the older people how they formerly treated their waste e.g. composting of organics. For teenagers it can be hard to accept the example from the parents thus they might react in opposing everything coming from the parents. In these cases it is even more important that the places they like to go e.g. clubs are an example for good behaviour. Mainly in cliques but also in neighbourhood or among colleagues group dynamics can be very important. This means that individuals act like the group and don't decide themselves. In case environmental aspects are trendy in the respective groups it is positive for waste prevention and minimisation but if this is not the case it is negative. Due to similar reasons these groups can have

control functions if the individual acts against common rules, e.g. in housing estates neighbours can observe others if they do not separate their waste.

The importance of **non-governmental organisations** (NGOs) in the international environmental co-operation has risen considerably in the last decades. NGOs took part in the development of waste minimisation policies in most countries. Examples where NGOs supported waste minimisation include information of the public and politicians, contribution to developing of industrial waste reduction agreements, development of waste management concepts and organisation of voluntary material recycling campaigns. [OECD 1998B]. NGOs can also have an influence on several aspects like public opinion or they can use some kind of pressure to make companies act (see example described above about dumping of the Brent Spar Oil Platform). In general NGOs are pro-active to enable solutions. To achieve their aims there are partnerships either within different NGOs or with industries. There are different networking possibilities as Enviro Link which provide extensive listings and many support services for NGOs including potential partners for projects. Partnerships for environmental aspects are e.g. the NGO-Business Environmental Partnership or the Business Partners for Development supported by the World Bank [UNEP DTIE 2001C]. There are different studies to examine the basis under international law for the integration of NGOs in Multilateral Environmental Agreements (MEA) or economic institutions [ECOLOGIC 2004].

Several **international organisations** deal with the problem of waste prevention and minimisation in different programmes as UNEP DTIE, UNIDO, OECD. This will shortly be described below.

- UNEP DTIE (United Nations Environment Programme, Division of Technology, Industry and Environment) promotes Cleaner Production (CP) (see chapter 2 and 3), Environmental Technology Assessment (see chapter 3) and sustainable consumption and production patterns. The strategy is to involve and consider stakeholders, networks, innovation, value chain, life cycle perspective, technology and consumer participation. The programme for CP will be implemented in five pilot countries and will then be transferred worldwide.
- UN DESA (United Nations Department of Economic and Social Affairs) leads a global initiative for improving environmental management accounting [UNEP DTIE 2001C]. UNIDO (United Nations Industrial Development) promotes Cleaner Production and supports National Cleaner Production Centres (NCPC) (see chapter 2 and 3). There is an UNIDO's Initiative on Technology Transfer and the Assessing Needs (TNA). It supports technology and policy formulation and execution at the national macro level and sector level. At enterprise level TNA provides a detailed approach to auditing the capabilities of business firms. North-south co-operation is vital to enable developing nations to gain techno-managerial capabilities and it should be complemented by south-south cooperation to achieve competitive production and economic growth through the process of technology transfer and acquisition. Some 17 countries from Africa, Asia and Latin America have already engaged in the self-assessment exercise. [UNIDO 2004A]

- Cleaner Production practitioners can promote existing relevant Cleaner Production guidelines and manuals for tackling priority waste streams, they can offer knowledge, conduct demonstration projects and training, provide technical assistance services and they can provide policy advice and lobby for Cleaner Production.
- OECD is concerned with waste prevention and minimisation. At several workshops on this topic they worked out definitions, Material Flow Analysis, a concept for strategic waste prevention (see chapter 3), the Pressure-State-Response model for identification of indicators (see chapter 8).

The role and opportunities of NCPCs (**National Cleaner Production Centres**) are manifold. They can help businesses by improving the environmental attributes of their products and services, by minimising the environmental impacts of their production activities, by identifying new markets for their greener products or services. NCPCs can also influence national policy by advocating on behalf of laws and programs designed to change production and consumption patterns. NCPCs can also collect and actively disseminate information about new approaches, technologies and pilot projects, catalyse multi-stakeholder networks to promote partnership and collaboration, offer appropriate education and training programs to industry and others, and assist in the establishment of targets and benchmarks for different sectors of the economy. [UNEP DTIE 2004A].

NCPCs promote, co-ordinate and facilitate Cleaner Production activities within each country. The purpose of the NCPCs is to build local capacity to implement Cleaner Production in developing countries and countries with economies in transition. True appreciation of Cleaner Production and its application can only come about if the concept is promoted by professionals and is adjusted to the local conditions.

NCPCs aim primarily to transfer know-how and not just to transfer technology. The Centres and the trainers do not deliver ready-made solutions. They train and advise their clients on how to find the best solutions for their own specific problems. Therefore, six basic services are provided:

- Raise awareness of the benefits and advantages of Cleaner Production
- In-plant Cleaner Production assessments and demonstration projects
- Training of local experts and building of local capacity for Cleaner Production
- Help to obtain financing for Cleaner Production investments
- Disseminate and exchange of technical information
- Provide policy advice to national and local governments

The objectives of the NCPC programme are to increase competitiveness, open access to new markets, stimulate public-private-partnerships, promote CP investments and CP technology development and transfer.

Acting as focal points for CP, NCPCs extend the global network to partners in their countries like productivity councils, engineers associations, chambers of industry, universities, etc.. This extensive network with its wealth of information and expertise allows the NCPCs to provide much better services to companies.

The primary beneficiaries of the programme are small and medium sized enterprises and large scale enterprises due to savings as a result of reduction in waste generation and resource use and due to training; industrial associations, research institutes, consultants, universities due to marketable research possibilities; environmental and industrial policy makers and financial institutions due to better awareness.

The NCPC programme organises annual meetings to evaluate the progress of the programme, to exchange experiences, and to discuss future activities to be undertaken by the centers.

There are NCPCs in the following countries: Brazil, China, Costa Rica, Czech Republic, El Salvador, Ethiopia, Guatemala, Hungary, India, Kenya, Korea, Lebanon, Mexico, Morocco, Mozambique, Nicaragua, Slovak Republic, South Africa, Sri Lanka, Tanzania, Tunisia, Uganda, Vietnam, and Zimbabwe.

UNIDO and UNEP have joined forces to support CP through NCPCs. Therefore, UNIDO is responsible for the overall administration, local liaison and provision of industrial expertise whereas UNEP is responsible for providing strategic environmental expertise. [UNEP DTIE 2004B, UNIDO 2004B]

Universities and research institutes bear profound responsibilities to increase the awareness and knowledge, develop new technologies and tools to create an environmentally sustainable future. They should increase education, (applied) research, training, policy development and information exchange. Concerning education it is important to educate the educators, e.g. educational planners, teachers. Activities can include the development of innovative graduate and post-graduate training programmes, organisation of conferences and seminars to facilitate the exchange of information and research findings, and organisation of panel discussions on specific issues to promote dialogue between industry, government and academia. [UNEP DTIE 2001C] In addition universities and research institutes perform many co-operation projects with other national or international research institutes or companies. Therefore, they are a motor for the transfer of knowledge and technologies.

Financial institutions can steer waste prevention or minimisation with financing selected projects or giving loans. So the award of financial means can be connected to special requirements, e.g. special management systems (EMAS, ISO 14001, Cleaner Production, etc.), participation in voluntary co-operations, fulfilling a special aim with the received money, future potential costs. Individuals with a comparatively smaller influence can invest their money in green financial investments. Banks, for instance, have established stocks in which only companies that adhere to special environmental requirements are taken together.

5.5 Conclusion

For an overall approach it is essential that all stakeholders come together and find integrated solutions. A sustainable improvement in waste prevention and minimisation is only possible by a co-operation of the stakeholders. For adequate decisions all stakeholders need to be supplied with information.

In a survey the relative significance of the stakeholders in developing waste minimisation policies and in meeting waste minimisation targets was estimated: Industry and related associations were considered to have the greatest influence, consumers were considered to have significantly less influence, environmental groups and other NGOs were considered to have even less influence (in particular, they were considered to have very little influence with regard to meeting waste minimisation targets). [OECD 1998B p.31 et sqq.]

The specific role of the stakeholders and their attitude towards supporting, being neutral or opposing waste prevention and minimisation activities is heterogeneous in different countries. Several countries considered that consumers and private households should be more closely involved in waste minimisation efforts in the future. In particular, attention should be given to improved information dissemination with regard to environmental impacts of processes and products, separate collection and recycling opportunities, how to use existing facilities and generally raising public awareness. Environmental groups and other NGOs should be more closely involved in waste minimisation in the future, in order to facilitate provision of information on waste minimisation objectives and targets aimed at increasing public awareness and multi-stakeholder consultations. Countries in which stakeholder participation was already high as in the Netherlands a necessity for a closer participation of stakeholders was not seen [OECD 1998B p.38-39].

6 The role of differences

6.1 Between important industrial sectors

6.1.1 Three sectors

The economy can principally be divided in three sectors: a primary sector, a secondary sector and a tertiary sector. The primary sector generally includes basic or extractive industries, farming, forestry and fishery. The secondary sector comprises the processing industry and the tertiary sector covers services. As the sequence of the terms already shows, at the beginning of an industrial development the primary sector is predominant, then the secondary sector achieves more importance and in a further development the tertiary sectors grows. Thus developing countries are mainly characterised by the primary sector. Typical for countries with economies in transition is the increasing importance of the secondary sector. In industrialised countries the tertiary sector grows.

Extractive industries produce a high amount of residues with generally little danger. But hazardous residues can also arise depending on the extracted material. For the extraction of gold the mercury-amalgamation approach was formerly used and is still used in Brazil or Indonesia. The highly toxic mercury contaminates rivers, soil and lakes. This approach was replaced by the approach with cyanide whose residues are still a danger for the environment. So in 2000 a disaster took place in Baia Mare in Romania as a dam of an oxidation basin broke and a high amount of cyanide solution entered into rivers. This killed all life in the area it passed by. In industrialised countries this approach is prohibited but other countries cannot afford to introduce corresponding regulations. [KESLER 1994]. This emphasises the problem that industries may work with obsolete techniques which can be a potential danger for the environment. Depending on how farming and forestry is performed there can arise a lot of waste which has principally a natural origin and is therefore not hazardous. However, it can pose a problem when intensive mass animal farming is done.

In processing industries all kinds of different wastes arise (see 6.1.2). Services generally produce less waste with little danger than processing industries but this waste is mixed and arises at many places. This is a problem for collection and recycling.

6.1.2 Different kinds of waste in different branches

In the construction industry great amounts of waste with low potential of danger arise. On the other hand, in this branch secondary raw materials from other industries can be used. In the chemical industry wastes with a high potential of hazard arise. In this industry also large uniform material flows can arise. By collecting them separately the return into the process is possible, e.g. by a profitable technological adaptation. For instance used PVC (polyvinylchloride) is returned into the original manufacturing processes.

In the energy industry coal or other fuels are used as energy supply. Slags and ashes result out of the incineration process. Their amount is not negligible and a risk for the environment is given.

In branches with expensive raw materials higher financial incentives for reducing inputs respectively returning material flows into the process exist than in branches in which the price for raw materials are negligible.

6.1.3 Large and medium sized companies

There are also differences between large and medium sized enterprises since the large enterprises have higher capacities for caring about implementing concepts or strategies mentioned in chapter 3. They could also afford to displace parts of their production abroad where less environmental regulations are or where it is cheaper. Thus regulations affect medium sized industries more.

6.1.4 Different legal backgrounds

Differing from country to country not all industrial sectors are concerned by ordinances or voluntary agreements. Therefore, the willingness or the necessity to act is different. Waste legislation is established over the time depending on the identification of problems. In 2002 the European Directive on Waste Electrical and Electronic Equipment was introduced because a growing amount of waste from electrical and electronic equipment was identified due to rising consuming patterns in this field such as mobile phones.

The higher the grade of organisation in a country in regard to the economic structure the easier is the introduction of economic instruments. This is due to the possibility to agree upon these instruments with associations representing a branch instead of agreeing upon them with single companies.

There are also different specific recovery quotas and disposal requirements in different regions and countries. Due to this aspect costs for waste treatment are different leading to different burdens for the industry or to the transport of wastes to other regions. This can influence the competition of the companies.

6.2 Regarding local conditions in general

Local conditions vary significantly between different countries or regions due to the following factors:

6.2.1 Geographic factors

Area and dimension: If a country has a lot of space it is no problem to dispose of the waste on landfills. So there is no need to search for alternatives to either reduce the waste or treat it. Examples for vast countries are Australia and China predominantly using landfills [ENDRUKAITIS 2003]. But for instance in Japan or in Germany there is no space for disposal of the amount of wastes produced. Hence, these countries have developed reducing or treatment methods and a legislative background to avoid or minimise landfilling. In vast countries there can occur problems in execution of legislative specifications because it is difficult to control them in remote areas.

Topography: The topography determines whether the logistics for the transport of waste to the site for recycling or landfilling is easy or difficult. A difficult logistic can represent an obstacle for the development of a recycling net-work. But on the other hand it is more difficult to find a site for a landfill in a mountainous region. Therefore, one might think about other alternatives than landfilling.

Climate: The climate influences the stability and durability respectively the sensitivity of technologies or products. Before a technology is transferred it has to be analysed if it will properly function under the climatic conditions in other countries. There can be higher evaporation or a higher risk of corrosion due to for instance the proximity of the sea or an abrasion due to

mechanical stress e.g. sandstorms. A natural example for different climatic conditions is the sensitivity for weathering processes of granite. Granite is a stable rock in temperate climates whereas it is sensitive for weathering in dry climates. A big mistake in this context in the seventies, for instance, was the transfer of technology into the region of the Sahara. After the period of a year the technology was broken and spare parts could not be purchased. This emphasises the necessity to adjust the technology and to use tailor made equipment.

6.2.2 Demographic and infrastructural factors

Infrastructure: Like the topography, the infrastructure of a country is determining the logistic of waste collection and transportation.

Population density and distribution: The density and distribution of population influence the logistic of waste collection and transportation. In rural areas it can be difficult and expensive to provide waste collection systems to every household since the distance can be far. The problem of far distances is given, for instance, in Finland or Namibia. The population density is jointly responsible for the amount of waste produced. In mega cities distances to treatment stations or landfills can be far and no space for transfer station might be given. When people live in cities it is easier to reach them by awareness campaigns.

Overpopulation and growth of population: These two factors deteriorate the waste situation so that the amount of waste grows exponentially. Then existing landfills or treatment plants can quickly be too small.

6.2.3 Social factors

Educational background:

- The educational background affects the creation of awareness for waste. If people have a low educational background they may be unconcerned about the waste problem and they may not be able to estimate or to know the impacts of waste.
- Especially in industrialised countries problems with waste exist already for a long time. Therefore, people have developed some kind of awareness. But if the problem is recognized only for a short time few people are concerned about. This means that the awareness principally rises over the time during which the problem is recognised. But if the topic is no longer present for instance in the media the awareness may decrease again.
- In addition, people not well educated or not having experiences may not comprehend, analyse or overlook new technologies which are offered to them by international companies to solve their problems. But they hardly can check if the offered technology is really the best solution for their problem. Therefore, they are depending on the supplier. But the supplier usually has its own interests to sell its technology. So here is a danger given which can be reduced by know-how transfer in form of capacity building training for decision makers to enable them to decide professionally.
- Different systems of education lead to different behaviour. If classes are held in an ex-cathedra teaching with the aim that students only reproduce what they have heard they do not question things but take them as they are. In contrast, questioning means giving oneself bareness in some countries. By this kind of teaching no analytical thinking, no own initiative, no team work is supported. In other countries

the following saying is known: “Who doesn’t ask remains stupid”. One can imagine that in these countries people are more likely to question things.

Living standard:

- The living standard influences what is important for the individual. If somebody is poor the most essential is to survive, to have enough to eat and to know where to sleep. These people will not think of the waste they produce but they also don’t produce much waste. In contrast some of these people live on landfills or from landfills by collecting valuable material from the waste. If one intends to reduce waste or recycle valuables one has to think about these people loosing their living basis which can turn into a social problem.
- With rising living standard the amount of waste is increasing and therefore the necessity to act. In this case people could afford to think about waste. Thus awareness campaigns should be initiated.
- An example of different thinking is given by the proposal to go shopping with reusable bags instead of using new plastic bags. In some industrialised countries people act accordingly due to the price of new plastic bags. In developing countries colourful bags from supermarkets are a sign for prosperity. As people in these countries want and need to rise their prosperity it would not be reasonable to change this behaviour for the moment.

6.2.4 Other factors

Type of government and economic system: The attitude of people and their behaviour are linked with the type of government and with the economic system. In a democracy and a free market economy individuals can easily participate and commit in the system. In a dictatorship people have to function in a way the systems dictates it. No own initiative is wanted. In a socialism or communism based on a planned economy people work for joint belongings. Therefore, they have less responsibility or self-interest at work. Responsibility, own initiatives and motivation are principally supported in a democracy. Therefore, people will more easily think of problems concerned with waste. In addition, the political and economic systems influence the legal position, the possibility and mix of the instruments.

Historic differences: The development of the waste discussion differs from country to country. In the beginning there was usually wild dumping of all kinds of waste. Then the necessity of rules for the disposal was observed and finally the closed loop recycling management was introduced in some countries. Influences on this development can be traditions, warlike conflicts and necessities due to other factors described above. This historic development influences the present state of waste legislation and waste treatment methods. For instance, in the north of the European Union incineration operations are mainly used whereas in the southern and eastern part of the European Union landfilling is predominant.

The status of development of a country clearly influences the priorities of action. At the beginning of a development an increase in prosperity is essential. After being aware of environmental problems first of all air pollution will be rectified, second priority concerns fresh water and waste water. Finally the waste problem is recognised because its impacts are more locally and less effecting humans.

Legal differences: The legal background of a country is responsible for the impact of further instruments. In countries where many aspects are already strongly regulated by mandatory instruments as it is the case in Germany the scope for economic instruments is smaller than in countries with less strongly regulated structures like Hungary.

Due to different legal backgrounds the environmental requirements are usually weaker in less developed countries. This may be used as bait to attract investors which are needed in the countries for a further development.

Differences in decision making: Also policy approaches and ranking systems by which priorities are set and most appropriate measures are selected, will not be identical in all countries either. This can lead to different results in the mix of instruments, concepts and aims. Reviewing current practices indicates that local considerations have an influence on both the ranking and selection of waste minimisation tools. [OECD 1998A]

Religion and culture: Depending on the ideals of a religion it can support the awareness process for waste prevention and minimisation or it can hinder it. If a religion includes the preservation of the creation or the nature it supports the principal thinking of not affecting nature. Religion can also promote justice of generations. Also the culture of people influences the thinking. A culture may be close to nature and live from nature in a sustainable manner or a culture can be far away from nature like the consumer society. Due to customs people can think and act only short-term from one day to the other or people can think in long-term and plan things ahead. Being closely connected to nature is positive for the awareness as well as thinking long-term because then one can more easily comprehend the impacts of waste on the environment.

The hierarchical structure of a family, a company or a society depends on socio-cultural backgrounds. When the hierarchy is strong people have much respect for the older people, patrons, directors or the father. Thus they will not oppose what is said by these people but will follow what they say without questioning it. On the one hand, these leaders could use their power in favour of waste prevention and minimisation but on the other hand individual persons are not educated to think themselves so they don't show own initiative or motivation without being told what to do. In these cases people might not critically reflect what they do.

In regard to transfer know-how and technology the cultural background of the participants strongly influences negotiations. For instance, Asians have a different way of discussing and finding solutions than Europeans or Americans. This has to be considered in preliminary stages of negotiations.

Financial differences: Some concepts for waste prevention or minimisation are costly so that some countries or industries cannot afford it.

6.3 Conclusion

An important ulterior motive is that discussions about and measures for waste prevention and minimisation have mainly be developed in industrialised countries. On the one hand, these measures have to be expanded and improved in industrialised countries and on the other hand developing countries need to consider the waste problem to avoid the mistakes made by northern countries. As the industrialised countries have recognised where they have made mistakes this knowledge should be used to help other countries not to commit the same mistakes again. So it would be appreciable to transfer this know-how and the tech-

nology. At the same time one has always to take into account the differences described above. It is not reasonable to transfer exactly the same know-how or technologies as theay are used in the original country. When the transfer is effected into similar regions or countries less problems will occur. A transfer is recommended but on the other hand developing countries have to make their own experiences to find their own way just as teenagers need to make their own experiences even if parents could help them in advance. A healthy balance between paternalism and support has to be found.

Due to the described differences know-how and technology has always to be reviewed whether it is reasonable to be applied and transferred or not.

7 Maximum effect sectors

The maximum effect sectors cannot be determined worldwide because they can vary from country to country or region to region. In addition maximum effect sectors can be determined in regard to the amount of waste, the hazard and the energy content of waste. These different aspects are responsible for the complexity of evaluation of the maximum effect sectors. History shows that actions or legislation processes usually start by handling or preventing hazardous waste. When these waste streams are controlled additional waste streams respectively sectors will be concerned.

Priority waste streams are defined by different organisations for different programmes. These include mainly packaging waste, construction and demolition waste, industrial waste, end-of-life vehicles, waste of electrical and electronic equipment, used oil, waste tyres, used lead-acid batteries, and pesticide waste. In several countries there are intensive efforts for preventing respectively recycling of packaging. This is not due to high amounts of waste because the amount of packaging collected with the Green Dot System in Germany is only about 3 % of total household waste. But plastics have a high energy content corresponding to about 13 % of household waste.

Quantitative relevant waste streams in the European Union are industrial wastes (between 1/5 and 1/4), mining wastes (between 1/6 and 1/3), construction and demolition wastes (about 1/6), municipal wastes (about 1/6), agriculture and forestry wastes. These waste streams sum up to about 90 % of the waste generation. [COMMISSION OF THE EUROPEAN UNION 2003, p.64] But these waste streams especially mining wastes, construction and demolition wastes are differing considerably from country to country depending on the industries active in the countries. An overall comparison for the European Union is not possible due to the quality of the statistics. Therefore, an analyses of the levels and trends of waste generation is not possible. (see chapter 8) [COMMISSION OF THE EUROPEAN UNION 2003, p.67]

In some European countries industry is responsible for over 75 % of the amount of hazardous wastes. The data points out that the chemical industry and the metallurgical industry produce most of these hazardous wastes. [COMMISSION OF THE EUROPEAN UNION 2003, p.64-66]

Especially in developing countries or in countries with economies in transition the maximum effect sectors can be totally different because they depend among other things on the industrial activity (see chapter 6).

In many countries like China or Romania it is hardly possible to get information about companies' activities. So there is virtually no data available. Due to this fact a control of or an influence on the produced waste is not possible.

The potential of waste prevention or minimisation depends among other things on the present status of waste prevention and minimisation. In countries where a lot of efforts for waste prevention and minimisation have already been undertaken the potential is lower than in countries where no or only few measures have been implemented. Therefore, even in similar structured countries the maximum effect sectors can be different.

Maximum effect sectors generally depend on:

- Level of industrialisation
- Specification of industrial sectors
- Setting of objectives and level of achievement of objectives
- Complexity due to consideration of amount, hazard and energy content of materials or waste
- Nature of waste products, waste flows and waste materials. Different gain for the environment by a stronger recycling depending on the nature [COMMISSION OF THE EUROPEAN UNION 2003, p22]

For evaluating the maximum effect sectors in the single cases considerations have to be made to decide which sector can bring maximum effects. Here the possible future development should be considered. For instance, there had been an evaluation on potential waste prevention or minimisation amounts in the German chemical industry in the early nineties. Due to a low economic growth the analysed prevention potential was even exceeded in reality. This shows the difficulties for a prognosis. A good method is the value benefit analyses or the cost benefit analyses. When regarding costs also the external diseconomies should be evaluated as far as possible. Life Cycle Analyses or Material Flow Analyses are principally good instruments to evaluate the impacts of sectors but these analyses are quite complex.

In the following the **value benefit and cost benefit analyses** are shortly explained. A value benefit analyses is a comparison of values for all kinds of decisions and self-defined benefits. A cost benefit analyses is similar but includes also the costs or revenues of the considered aspect. As benefit the amount of waste, its hazard, its energy content or recyclability can be considered. For a quantification of these benefits suitable criteria for their valuation have to be determined. In addition, the importance of the single benefits to each other have to be defined so that they can be weighted against each other. Within a matrix these benefits are evaluated by relative points.

In Table 7-1 such a matrix with exemplified points is shown. In the first column the benefits are listed, in the second and third the points given for two exemplified waste categories are shown, and in the last column the valuation scheme it explained. The possible points in the example range from 1 to 5 and the single benefits are weighted equally. The result is determined by adding up the points of the single benefits. The chemical waste has then 14 points in comparison to 13 points of the construction waste. So in this example one would favour to introduce measures for the chemical waste.
Depending on the depth of such an analyses it can be a quick method. If it is difficult to determine or evaluate the benefits or costs the complexity of the analyses is higher. These analyses have a strongly subjective valuation.

Table 7-1: General scheme of a value benefit analyses

	Waste categories		
	Construction waste	**Chemical waste**	**Valuation**
Amount	5	2	1 = low amount 5 = high amount
Hazard	1	5	1 = low hazard 5 = high hazard
Energy content	1	3	1 = low energy content 5 = high energy content
Recyclability	2	2	1 = low recyclability 5 = high recyclability
Cost for prevention	4	2	1 = high costs 5 = low costs
Valuation	13	14	

8 Indicators for waste prevention and minimisation

8.1 The need for indicators

Waste prevention and minimisation is certainly one of the key issues addressed by environmental policies of many countries. Usually it also represents an important element of their sustainable development strategies. Consequently, those countries require **reliable factual information** about waste and also appropriate measurement tools to specify and assess the performance of their waste prevention endeavours. In this respect indicators play a significant role as they are basically used for planning, clarifying policy objectives and priorities, assessing performance and communication with the public.

Principally, indicators are used to elucidate impacts and changes of complex systems in a simplified manner. Take, for example, a clinical thermometer that indicates an increased blood heat and thus warns against undesirable diseases. Similarly, indicators on waste prevention and minimisation can help to identify certain deviations from a targeted or expected development. And they can show both the environmental status as well as the reasons for that status. Moreover, they are needed in order to fulfil the following set of purposes [OECD 2002A]:

- Indicators allow to measure policy targets
- Indicators provide the basis for an assessment of past or projected policies
- Indicators enable a comparison of developments between regions, nations or other entities (both improvement or deterioration)
- Indicators assist policy dialogue and information
- Indicators increase public awareness
- Indicators allow for trend assessments and analytical descriptions
- Indicators can motivate actors to devote more time, effort and responsibility
- Indicators can identify bodies experiencing strong impacts
- Indicators can determine the contribution of waste prevention and minimisation to environmental preservation, resource conservation and sustainability.

Therefore, indicators either can serve as measurement tool ex post, e.g. observing and explaining past developments, as well as early-warning system ex ante, e.g. identifying potential future developments. Both types are currently in use by various nations and organisations in order to survey national and international policy, commercial activities and also societal behaviour.

8.2 Indicators currently in use

A large number of indicators concerning waste generation and management is applied by national or regional governments and also by national or international organisations. Depending on the respective reporting, controlling or information purposes those indicators diversify in their content, scope and, of course, their data sources. Most notably are the concepts developed by the OECD, the Commission on Sustainable Development (CSD) of the

United Nations, EUROSTAT and the European Environment Agency (EEA). For Germany also the DUX (German Environment Index) established by the Federal Environmental Agency should be mentioned as it represents a complex system of indicators related to climate, air, soil, water, energy, and resources. Taking a more general perspective indicators basically can be directed towards environmental mediums, environmental strains, environmental problems, environmental areas, natural resources and precautionary measures. [ZIESCHANK 2002]

Subsequently, a few examples of different sets of waste indicators will be presented. First, there is a set of indicators established and reported by the OECD with the target of gathering information on the amounts of waste generated, its composition, treatment and disposal methods. They cover municipal waste, industrial waste, and hazardous waste. However, their scope is limited to the OECD member countries. Table 8-1 illustrates the set of OECD-indicators [OECD 2002B]:

Table 8-1: OECD indicators on waste generation and management

Generation and composition of waste	
Waste generated by sector	Agriculture Mining and quarrying Manufacturing industry Energy production Water purification and distribution Construction Municipal waste Other
or by source	Construction-demolition waste Dredge spoils Sewage sludge Excess manure End of life vehicles Used tyres Electric and electronic scrap Min./synthetic oils Packaging waste (paper, plastics, glass, metals)
Municipal waste including household and other municipal waste	Generation of municipal waste: Total amounts generated Amounts per capita Composition of municipal waste: Paper and paperboard Organic material Plastics Glass Metals Textiles and other

Generation and composition of waste	
	Treatment and disposal of municipal waste Total amounts % of population served by municipal waste services Recycling Composting Incineration with energy recovery Incineration total Landfill % landfill Other
Industrial and hazardous waste (production, movement and disposal)	Production Imports Exports Treatment & disposal Recovery Physio-chemical & biological treatment Thermal treatment Landfill Release into water Other
Nuclear waste	Spent fuel arisings
Waste management	
Treatment and disposal of waste	
Population served by municipal waste disposal	
Recovery and recycling of selected products	Waste recycling rates of paper and cardboard Waste recycling rates of glass
Treatment and disposal installations	Landfill sites (controlled and uncontrolled) Number Remaining capacity Annual input Incineration plants Number Annual capacity % with energy reclamation Treatment plants Permanent storage Others

Another set of indicators is offered by the European Environment Agency (EEA) recently published in their report “Europe’s environment: the third assessment” [EEA 2003A]. Like the OECD they basically classify the indicators into waste generation and waste management indicators. Table 8-2 illustrates those indicators in more detail:

Table 8-2: EEA indicators on waste generation and management

Generation and composition of waste	
Total waste	Total waste generation Total waste generation per capita Total waste generation per GDP per capita Total waste generation by sector Construction & demolition Mining & quarrying Industrial waste Municipal waste Energy production Not declared
Municipal waste	Municipal waste collection per capita Waste generation from household and commercial activities Landfilling of biodegradable municipal waste as a percentage of total biodegradable municipal waste
Sewage sludge	Generation per capita Treatment per capita Incineration Recycling Landfilling
Hazardous waste	Hazardous waste per capita Substantial contributors to hazardous waste (sources) Types of hazardous waste Percentage change in hazardous waste generation in the period 1995-2000
Manufacturing waste	Food Wood Paper Chemical Non-metallic mineral Basic metal Other

Waste generation	
Waste from mining and quarrying	Domestic extraction of fossil fuels Domestic extraction of construction minerals
Waste management	
Municipal waste management	Disposal in % Recovery in %
Hazardous waste management methods	Recovery Incineration with energy recovery Recycling Composting Other recovery methods Disposal Other Physico-chemical or biological treatment Permanent storage Release into water-bodies Unspecified/not declared
Landfilling	Number of landfill sites

The existing indicators on waste generation and management are influenced by various factors such as the GDP. Therefore, their trends cannot give reliable information whether applied instruments are successful. Despite these indicators exist and are collected in different countries the statistics are not comparable even not within the European Union. [EEA 2000, EEA 2003B].

An example for this **limited comparability** is the municipal or household waste. The definitions commonly used are inconsistent as they refer to management and collection concepts differing from region to region. In addition the German Ordinance on Waste disposal that – other than the respective European regulation – also considers sewage sludge and construction waste as being municipal waste. [KOPYTZIOK & SCHWARZ 2002] Hence, those definitions allow for a dissenting interpretation and consequently may lead to a deviating calculation, too. In such a case one would compare apples and oranges without knowing and probably draw wrong conclusions. An attempt to overcome this problem is the European regulation on waste statistics which shall unify the data.

Indicators on waste prevention and minimisation are not always stated in an explicit manner. Sometimes they represent an underlying variable of an index like, for example, the **Environmental Sustainability Index** (ESI). The ESI comprises a set of 20 core indicators and a total of 68 underlying variables. Representing a first step towards a more analytically driven approach to environmental decision-making it seeks to permit cross-national comparisons of

environmental progress in a systematic and quantitative fashion. In terms of reducing waste and consumption pressures as one indicator for environmental sustainability the ESI is, among others, determined by variables such as “Ecological footprint per capita” and “Radioactive waste”. [GLOBAL LEADERS OF TOMORROW ENVIRONMENT TASK FORCE 2002] As total waste generation in most countries is still on the rise and decoupling of waste generation from economic growth is not realised on a global basis yet waste prevention and minimisation efforts maintain vital importance for a sustainable development. Therefore, it appears favourable to account for appropriate and powerful indicators also within a compounded index or barometer like the ESI even though such indicators face the image of being far to inexplicit.

8.3 Constraints of indicator’s use and interpretation

The following enumeration lists the constraints of indicator’s use and interpretation. It doesn’t claim to be a complete enumeration.

- Lack of available and comparable data is the biggest constraint. Quickly this becomes apparent whenever a comparative statistic on waste prevention issues is analysed, i.e. most of the indicator numbers are omitted or restricted in terms of their significance.
- Lack of specific methodology in developing and applying waste prevention indicators meaning cases where actually the same indicator is applied but the relevant data is recorded and is compiled differently.
- Different dates and baseline years and the omission of unreported wastes
- Lack of explanatory and defining guidelines
- Inconsistent definitions of waste across time and space
- Lack of a legal mandate to undertake evaluations.
- Lack of adequate financial resources for activities.

Apart from above mentioned constraints that can be regarded as being inherent to the system of indicators there are constraints that pertain to the characteristic of waste prevention itself. In this regard many definitions of a successful waste prevention may exist due to prevention of amount, hazard or energy content. Effects of waste prevention are influenced by timing, diversity and complexity, and there is a magnitude of heterogeneous activities contributing to waste prevention.

As **different ways of defining successful waste prevention** exist, it is difficult to assess whether waste prevention really occurs. With a pure relative, but not absolute, perspective it can happen that although the amount of municipal waste per capita declines, the overall municipal waste generation rises. Also, when there is a quantitative, but not qualitative, perspective on waste prevention it is possible that the amount of packaging measured in tons is declining due to a shift from glass to plastic or aluminium but the energy to create and dispose the packaging increases. Both cases can be construed vice versa, for instance, that there is a qualitative waste prevention as reduction of hazard or energy content, but no quantitative waste prevention and likewise they result in a misinterpretation of success. This emphasises the need that not only the waste category “packaging” should be considered also the material has to be accounted.

Concerning the **timing of waste prevention efforts** must occur before products or materials are recognised as waste. Consequently, these measurements try to evaluate what is not there thus data on waste prevention will hardly exist. In addition, similar waste prevention measures can show their impact with a time shift, for instance, when the design of products is changed towards longer life time or recyclability especially when regarding products with different life times such as cups or fridges. Taking these and all secondary effects into account would be a prerequisite for a sound evaluation of waste prevention measures but seems not to be practical or cost-effective. Thus currently indicators for weight or volume are still used.

For all indicator there is also the **question of interpretation** which can represent a strong constraint, too. The following example seeks to explain that issue. Sustainable Development emphasizes - among other topics - the reduction of material and energy consumption. In order to assess this goal many nations did establish indicators like raw material productivity or energy productivity. Those indicators usually measure the respective consumption (physical units) in relation to the GNP (Gross National Product) (monetary units). And basically, there are two scenarios that lead to an improved productivity.

- Scenario A raises the GNP (output) whilst keeping a constant level of resource consumption (input).
- Scenario B, on the other hand, reduces the consumption (input) whilst generating the same level of GNP (output).

Considering waste prevention and minimisation, however, it is not sufficient to exclusively observe the development of the indicator itself. That is because of the fact, that scenario B can also be achieved when there is a pure change in the GNP composition meaning an increased proportion of the tertiary sector which naturally generates less waste than the industrial sector. Consequently, the interpretation of indicators requires distinguished knowledge about the driving factors.

The **various parties** involved can contribute to an improved waste prevention by truly different means and activities. Households, for instance, can purchase products with reduced packaging. Industry, on the other hand, can also design and offer products bearing less packaging. And governments, of course, can foster waste prevention by accomplishing green procurement themselves. Thus, the heterogeneity of activities complicates the decision of which activities to be analysed by indicators.

Even in cases where indicators perfectly reflect technological solutions and other achievements in waste prevention it is not possible to rule out the **complexity of indirect parameters** such as cultural shifts. That means, for example, a rise in environmental awareness or a modification in consumption patterns. Hence, waste prevention will remain delicate to be observed appropriately, particularly for international comparisons. [OECD 2002A]

8.4 Development of indicators

Above we have seen that a big variety of indicators regarding waste generation and management does exist and that several constraints are related to them. The lack of progress in developing specific waste prevention indicators can partly be explained by the complexity inherent in creating such metrics. Thus there is a need to develop new or to amend existing indicators while paying attention to the following aspects:

- Need for uniform definitions of the indicator and its parameters
- Need for a uniform application of the respective definition
- Need for representative and consistent indicators dependent on the topics and addressees
- Need for a uniform data collection process
- Need for reliable and obtainable reference parameters
- Need for uniform reference years
- Need for a strong communication potential
- Need for long term indicators

In addition the differences mentioned in chapter 6 need to be taken into account while setting up respectively comparing indicators.

A strong communication potential is given whenever the indicator is adaptable to a variety of audiences (policy makers, industry, citizens etc.), is limited in number, is remaining open ended, is adaptable to future developments, is interesting to all kind of decision makers, is understandable (i.e. clear, simple and unambiguous) and capable of being updated at regular intervals. [OECD 2002A]

In order to account for all these prerequisites of feasible indicators for waste prevention and minimisation a professional approach together with an integrative process becomes essential. One of these professional waste prevention indicator frameworks is represented by the Pressure-State-Response-Model of the OECD. Principally, the model is based on the fact that human activities exert pressures (waste generation) on the environment and change the condition of the environment (the state). In turn, governments and other social actors are likely to respond to these changes through a wide range of activities, including policies and expenditures. Consequently, it distinguishes pressure indicators, state indicators and response indicators. Table 8-3 illustrates examples of indicators [OECD 2002A]:

Table 8-3: OECD Pressure-State-Response-Model

Pressure indicators	Direct pressures Quantitative: e.g. total waste, packaging waste, electric and electronic equipment, construction and demolition waste etc. Qualitative: e.g. hazardous waste generation trends, greenhouse gases emission potential of wastes Indirect pressures Drivers: e.g. GDP, government consumption, population size Inputs: e.g. total material input
State indicators	Air: avoided emissions like NO_x, SO_x, methane, dioxins etc. Water: avoided waste-related contamination of surface or ground water Soil: avoided waste-related contamination of soil Land: avoided overall land use Noise: avoided noise impacts from waste recycling and disposal infrastructure
Response indicators	Regulations: e.g. waste policy concepts, product take-back requirements material or product bans Expenditures: e.g. funding for household compost bins Economic inst.: e.g. unit-based fees, deposit-refund Technology: e.g. market share of waste preventing products/processes Education: e.g. newspaper and television ads

As basic principles for any further development of waste prevention indicators the German Council of Environmental Advisors recommends to account for [GERMAN COUNCIL OF ENVIRONMENTAL ADVISORS 2002]:

- Consistency: Indicator must fit to the topic or target.
- Representativeness: Indicator must enable the description of the development of certain topics.
- Commitment: Indicator must be acceptable to important actors for a longer period of time.
- International comparability: Indicator must be internationally comparable in order to support benchmarking.
- Priority of operation: Indicator must account for the most crucial operations.

All things considered, however, we face the fact that despite having a sound and professional waste prevention framework indicators are still used to elucidate impacts and changes of complex systems in a simplified manner and thus may deviate from the absolute truth. Therefore, it is particular important to be aware of the relevant constraints of indicator's use and interpretation,. Irrespective of all the theoretical and practical constraints regarding waste

prevention indicators they serve for their purpose as long as the constraints are noted and considered for interpretations. Indicators can improve environmental measurement by providing means for reporting concerning key areas.

When suitable indicators are found targets for waste prevention or minimisation can be set up on a national and/or international level. These targets could content Multilateral Environmental Agreements so that each country should achieve these targets until a certain deadline. Difficult in such an approach is the agreement upon targets. While setting them up it has to be taken into account that several countries already have made efforts to prevent und minimise their waste. Based on a reference year those achievements have to be taken into account, for instance, by considering the realized improvement or by adapting the respective targets. In this respect one cannot demand the same (relative) reduction from each country.

Indicators will gain importance for policy makers if they will be comparable and appraisable on an international level which is the starting point for the subsequent idea of benchmarking indicators.

8.5 The idea of benchmarking indicators

Subject to this report is also the question how to transfer know-how, concepts and instruments regarding waste prevention from one nation or region to another. For this purpose it is essential to identify the most appropriate solution to be transferred, i.e. the so-called best practice solution. A popular tool for a sophisticated determination of the best practice is the benchmarking tool [BAUM et al. 2002]. Although the benchmarking tool is normally used on an enterprise level it could also be modified for benchmarking waste prevention activities. The fundamental idea of benchmarking is the comparison of a number of entities for different dimensions and for each dimension to identify the entity performing best practice. Thus, each entity can determine its position in the performance ranking and seek to learn and benefit from the best practice.

Benchmarking, furthermore, is not limited to pure performance measurement but rather focuses on continual improvement of the status quo. Therefore, repeated studies are required in regular intervals. Those benchmarking studies could be designed for national or international comparisons of monetary as well as non-monetary data. Benchmarking depends on data being available and comparable. In regard to the comparability of data, however, the benchmarking process takes care of a standardisation of data. Meaning that data is adjusted, for instance, by characteristics of differences like those factors of differences as already mentioned in chapter 6. However, best practice in one country needs not to be best practice in another nation since this depends on local, regional and national circumstances which have to be considered.

Yet, benchmarking of waste prevention indicators remains an idea but it would qualify for further research and development activities towards an improved and harmonised waste prevention system.

9 Previous failures and problems

Previous failures in achieving waste prevention and minimisation include lack of data, inadequate information, lack of system analysis and evaluation of results, lack of comprehensive cost-benefit approaches, lack of environmental sensitivity, lack of “how to” guidelines and inconsistent definitions of waste across time and space [OECD 2000, OECD 2002A].

The **complexity** of factors determining waste generation is high. They include the intensity of industrial activity, demographic changes, technical innovations, way of living and production and consumer behaviour. Due to this variety of factors it is difficult to treat waste prevention, resource management and product policy separately. This is probably the most important reason for the insufficient success of the existing political strategies. [COMMISSION OF THE EUROPEAN UNION 2003]

Major obstacles for increasing recycling rates are the higher organisational, legal and communicational requirements for **recycling** than for waste incineration or disposal. [EEA 2002]. In addition the costs for recycling are too high in comparison to other waste treatment possibilities.

Constraints for **implementation in industry** are manifold. They can either be financial, economic, policy related, organisational, technical or conceptual. Financial constraints include too high costs, a lack of funding mechanisms and possible risks. Economic constraints are the immaturity of the companies’ internal cost calculation and cost allocation practices. Policy related constraints are due to insufficient focus on waste prevention and immaturity of the environmental policy framework. Organisational constraints result from a lack of leadership, immaturity of environmental management function, information systems and employee involvement. Technical constraints are due to the complexity of waste prevention and conceptual constraints result from a general resistance to change. [UNEP DTIE 2002]

Also the **difficulty in measuring** the success of waste prevention and minimisation activities due to a missing data base is a problem. This means that there is a lack of indicators and consistently available data. Reasons for that are described in chapter 8.

The **aim to close the loops** of materials can hardly be achieved due to the fact that raw materials are often imported, e.g. animal feed, because then a recycling in the importing country is no real closed loop but a sink of materials [ISWA 2003, SCHENKEL 2003]. This should be considered in analyses as Life Cycle Analyses, cost benefit analyses or Material Flow Analyses. Within these analyses it has also to be checked if the recycling is reasonable that means if it has a positive net ecological impact (see chapter 3).

The **communication** between producers of goods and the waste disposal industry should be intensified so that products can be manufactured in regard to good recyclability [ISWA 2003].

Sham recycling is increasing. This means that waste for recycling and for disposal is mixed but only a part is recycled. However, the mixed amount of this waste is calculated as recycled waste. Therefore, a new regulation for industrial waste was introduced in Germany to regulate separated storage of these wastes to avoid fake recycling. But there is an execution problem due to legal procedures.

One has to pay attention that waste-economic legislations do not become independent as it happened in the case of the **packaging regulation** [SCHENKEL 2003]. The Green Dot Sys-

tem in Germany has established a monopoly which can hardly be broken through by innovative technologies which fulfil also the packaging regulation. The supremacy of the Green Dot System can influence further regulations. The Green Dot System now has branches in almost all European countries. This shows that instruments for competitive solutions supporting the free market economy might have advantages.

An **increasing recycling** is aimed at, but it doesn't only have advantages. An increasing recycling accelerates also the long-range distribution of pollutants and nutrients in contrast to approved disposal techniques. Therefore, it should be balanced in single cases which treatment is more reasonable in an overlapping environmental consideration. [SCHENKEL 2003]

A better **decoupling of economic growth and waste generation** has to be achieved. Therefore, the adequate legal and economic instruments have to be found and applied to promote best practice and the achievement of higher levels of recycling and energy recovery [PIN 2003].

The **European action plan** for the promotion of environmental technologies shows that it is still difficult to market environmentally sound technologies. Therefore, this action plan shall help to spread merchantable technologies respectively help technologies to reach readiness for marketing [FACHFORUM 2003].

The main precondition for an effective transfer is a **trustful relationship** between the people on site and the people introducing new technologies or know-how. This relationship can be achieved in projects running over a longer period of time.

A problem for an effective transfer can be short legislative periods. Such a period lasts, for instance, in Mexican communes only three years.

The different concepts mentioned in chapter 3 are **poorly integrated** with each other. At times, there is a lack of co-ordination between government departments. Usually, there are several government agencies with a direct stake in implementation of the different concepts, but their activities are not internally coordinated, and it is not uncommon that various ministries will pursue their own projects separately. Sometimes there are also inter-institutional tensions, and adversarial attitudes of players [ETC/WMF 2003F].

10 Basel Convention and its possible role

As this scoping paper shows there is a need for harmonisation to enable consistent communication and perception of waste prevention and minimisation. A similar detailed terminology applied identically in different countries is the basis for further steps. Therefore, the first focus should be set upon a harmonisation of terminology. Harmonisation should also be envisaged in regard to guidelines and regulations. Laws should be simple, comprehensible and should give a long-term perspective. Technical standards should be regulated in frameworks corresponding to adequate limits, for instance to ensure reliable quality of secondary material. Uniform indicators including consistent methods for data collection, to ensure comparability have to be developed and agreed upon (see chapter 8). Only with standardised long-term indicators reliable trends can be drawn up. Reliable trends are needed to evaluate applied instruments and their impacts. In all these aspects it is essential that the countries adopt the regulations and act accordingly.

It is not advisable to implement the same instruments or concepts uniformly for all countries. There cannot be a single strategy for all countries. This is due to the differences in the regions or countries like legal background, climate, industrialisation, different kinds of industries, different maximum effect sectors (see chapter 6 and 7). The different possibilities of concepts, strategies and instruments can generally be explained in guidelines and examples can be given which instrument is reasonable in which case or a methodology can be given how to find out the adequate instrument for a given problem. It is not adequate to principally claim recycling for every type of waste. To decide whether recycling of a given waste stream is the best alternative, analyses considering all environmental impacts over the life cycle should be performed to evaluate the net ecological impact. As discussed in chapter 7 maximum effect sectors can differ strongly from one region or country to another so it is hard to identify such sectors generally. Nevertheless, priority waste streams should be pointed out and common targets should be set up and reached. These priority waste streams can differ from the maximum effect sectors in different countries. Methods to evaluate these sectors in single cases can be explained and exemplified in guidelines. Examples are value benefit analyses or cost benefit analyses, Life Cycle Analyses or Material Flow Analyses. One can conclude that in the approaches described above it is reasonable to give a frame and a guide for individual solutions and measures.

The Basel Convention should try to support the approach described above. With over 150 participating countries the Basel Convention is a good panel to assist the elaboration of consistent terminology, regulations and guidelines, technical standards and limits, indicators and targets. As other organisations also deal with the problem of waste prevention and minimisation the Basel Convention should try to co-operate with these organisations to create and use synergies. As the Basel Convention only has limited possibilities of enforceability respectively no penalty possibility it should be tried to convince the countries with factual argumentation. Therefore, it is essential to emphasise incentives and individual advantages for single countries to facilitate their participation.

An essential point when discussing terminology or regulations is that the Basel Convention takes into account that the individual countries might not have enough options to implement resolutions. The European Union, for instance, provides many directives and policies which

have then to be implemented by the member countries. Thus confederations of nations should be integrated into the decision finding process.

The Basel Convention already promotes Environmentally Sound Management (ESM) which means taking all practical steps to minimise the generation of hazardous wastes and strictly controlling its storage, transport, treatment, reuse, recycling, recovery and final disposal. The purpose is to protect human health and the environment. [BASEL 2004].

A promotion of waste prevention and minimisation could be i.e. as additional part integrated into the promotion of ESM. The promotion should be increased to raise the awareness for this topic. It should contain exemplary success stories from pilot projects, information on approaches to reach waste prevention and minimization including information on terms, possible concepts, instruments, etc.

There are already different activities and programmes on sustainability from various international organisations (UNIDO, UNEP DTIE, OECD, EU). It should be ensured that the different activities linked with the subject of waste prevention and minimisation are networked and complement each other. At this point the Basel Convention could intensify its integration into these initiatives and co-operate with these institutions to use synergies instead of creating new concepts.

The NCPCs (National Cleaner Production Centres) and the Regional Training Centres (RTC) are a step for know-how transfer into developing countries or countries with economies in transition i.e. capacity building. They have a high potential for co-operation even though NCPCs and RTCs have different geographical and service scopes. Their actions include: Plant assessments and field visits, collection of information, assessment of the requirements for implementing ESM, recommendations for waste prevention at national and sub-regional levels, conducting regional workshops, training courses, seminars, evaluation of technically sound, economically affordable and socially acceptable technologies in relation to the specific situation, facilitation of the access to these technologies and providing continuous technical assistance to the involved enterprises, identification of opportunities for regional co-operation, including public-private partnerships, developing financial strategies, promoting case studies and pilot projects, scientific, technical and legal assistance to the parties [UNEP DTIE 2003]. As this list of actions shows, these centres implement several of the points mentioned in this paper to support and facilitate the transfer of know-how and technology. If the examination of their success and efficiency is positive these activities should be enlarged. A good idea is that the NCPCs and the RTCs co-operate and work together to use synergies of their actions.

The Basel Convention has direct influence or contacts on the political level. Politics in the countries, in turn, are responsible to implement the agreements within the Basel Convention which then have impacts on industries and consumers. The only direct influence of the Basel Convention on locals exists over the Regional Centres. These should be used to introduce the idea of waste prevention and minimisation wherever possible for instance during the planning of new industrial plants. Thus, the Basel Convention can help to rise the awareness for waste prevention and minimisation.

As waste prevention and minimisation is a very complex subject and many different stakeholders are concerned it is necessary that they come together to raise the awareness and to find suitable solutions. Therefore, the Basel Convention should seek out where it can support initiatives or partnerships of NGOs, universities, institutions, economy and consumers.

The strategy on waste prevention and minimisation proposed by the European Environmental Bureau includes setting of quantitative and qualitative targets, promoting the substitution of hazardous substances in the production processes, promoting the reduction of volume of waste produced, fostering the development and adoption of clean technologies and products, promoting the conversion of products to services, whenever possible, identifying ways to eliminate existing barriers to the competitiveness of the recycling sector by improving market conditions for recycled materials. Overall, transparency throughout the whole decision-making process plus the importance of ensuring the equal participation and treatment of all stakeholders are two crucial points to guarantee consensus and effective application of waste management policies. [EEB 2003]. Therefore, working groups should be set up with the main aim to:

- Assess existing national and regional initiatives on waste prevention,
- Identify the ‘vision’ and ‘best practice’ for what could realistically be achieved in the medium term on priority waste streams,
- Analyse the reasons why not all member states are using these ‘best practice’ techniques and the corresponding ‘barriers’,
- Identify what can be done to address these reasons and overcome these barriers,
- Propose specific measures and actions that can be taken to address these reasons and overcome these barriers,
- Develop indicators [EEB 2003]

The Basel Convention should examine whether they could support this kind or part of this strategy. Certainly it is reasonable either to set up working groups or to get more studies on waste prevention and minimisation since this study as scoping paper can only give a general introduction on many subjects.

11 Proposed Action Plan

As long-term perspective for the improvement respectively the implementation of waste prevention and minimisation the following actions are recommended.

- As a first step it is essential to harmonise the terms and the corresponding definitions. A focal point should be the question if waste incineration is considered as waste minimisation or not and the question which waste treatments are included in recycling. In this regard, the Basel Convention could initiate the discussion in co-operation with other international organisations such as UNIDO, OECD, etc. to clarify and determine the terms and definitions.
- Second, from the technical point of view it is important to have general consistent standards e.g. for recycling facilities or best available techniques. The standards need to be regularly adapted to the technological progress in order to support innovation.
- Third, priority waste streams should be pointed out. Therefore, different basic conditions of various regions or countries have to be taken into account. Specific targets for these waste streams for different regions or countries should be set up and agreed upon. The specific targets should be met by each country after a pre-determined period. The priority waste streams and possible targets could be elaborated in an additional study.
- Fourth, for these priority waste streams consistently defined indicators have to be developed and introduced as basis for the evaluation of measures and targets. Therefore, it is necessary that each country provides the corresponding data collected with the same methodology. In a further step, benchmarking of waste prevention indicators is an idea that qualifies for further research and development activities towards an improved and harmonised waste prevention system.
- Finally, it is not advisable to introduce the exactly same instruments or concepts uniformly in all countries. New instruments rather have to match and to be supportive to the existing structure of regulations and instruments. Further studies could analyse exemplarily which instruments are reasonable to be applied under certain given conditions.

Figure 11-1 illustrates the continuous loop of the above described steps. When the targets of the initial priority waste streams are achieved a new loop with additional waste streams or more ambitious targets will be initiated. Thus, the declining spiral expresses the increasing of waste prevention and minimisation.

In many aspects case-by-case decisions will be necessary to evaluate the net ecological impact of, for instance, waste treatment possibilities, because otherwise it is not possible to decide generally which waste treatment is reasonable. Only with a life cycle perspective considering basic conditions on site it is possible to identify the most environmentally sound treatment or action. This emphasises that it is not always reasonable to set up global regulations but to leave room for case-by-case decisions. Studies such as LCAs or value benefit analyses performed for specific waste streams can be the basis for decisions.

It is recommended to set up a working group to evaluate concrete suggestions and solutions for the above mentioned aspects. This group can be supported by additional independent studies about specific topics.

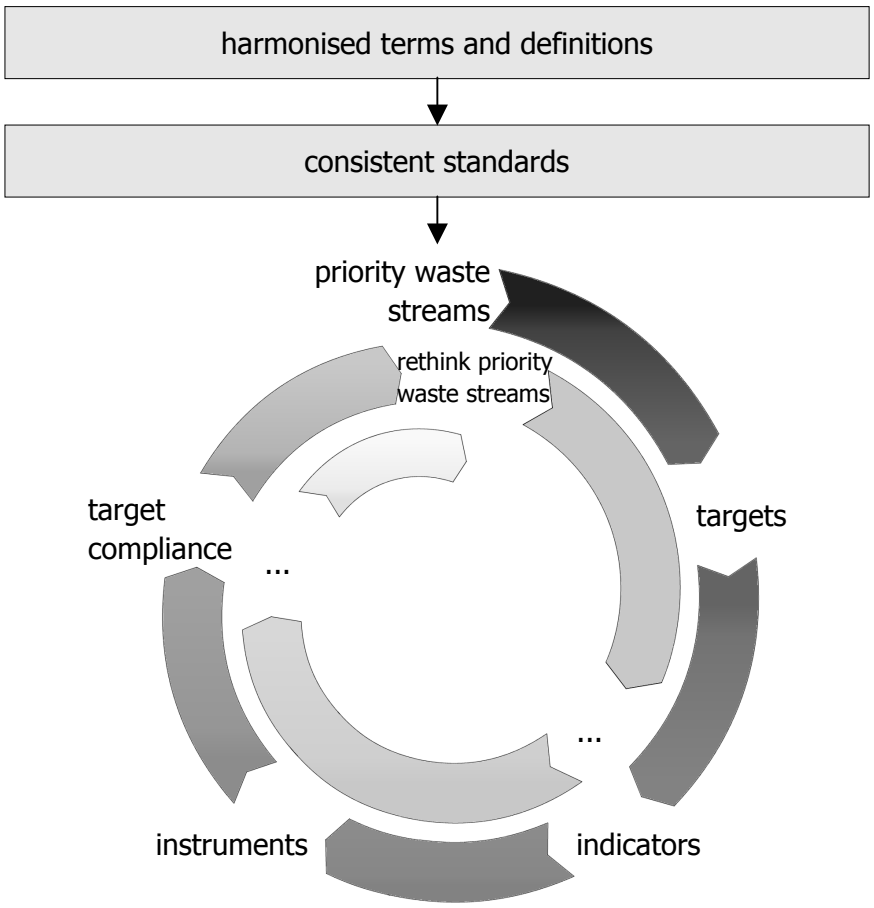


Figure 11-1: Waste prevention and minimisation loop

As the steps mentioned above are a global approach for harmonisation and enhancement of waste prevention and minimisation it will be difficult to implement it. It will take long time, a good financing as well as much effort before it will be implemented. To prevent inactivity in the meanwhile the following smaller actions are recommended as starting points which could be done by the Basel Secretariat:

- A guideline should be elaborated as practical aid for decision makers, politicians, enterprisers, consultants, administrators, etc. It should be a “how to do” guideline to help the practitioners to evaluate priority waste streams or maximum effect sectors for their region or country and elaborate the respective statistics, to select and implement proper instruments and concepts in regard to their individual circumstances concerning the aspects mentioned in chapter 5 and 6. The aim of such a guideline should be to give the practitioners tools to facilitate the individual approach for an enhanced waste prevention and minimisation. The tools could be, for instance, in form of a structured value-benefit analyses which exemplifies the advantages and disadvantages of instruments and give the criteria to evaluate a suitable ones. The elaboration of such a guideline could be a project within the Strategic Plan of the Basel Convention.

- Capacity building should be strengthened.
- Pilot projects with different topics and in different regions or countries can help to start a dynamic process in respect to waste prevention and minimisation. The topics can range from improvement of organisational, administrative or industrial structures over capacity building and consultation processes up to implementation of technological equipment.
- The Regional Centers are a good basis for an effective transfer of know-how and technology. They can support the exchange of experiences and consulting processes as well as capacity building. If the examination of their success and their efficiency is positive these activities should be enlarged. A good idea would be that these Regional Centers co-operate and work together with the National Cleaner Production Centers to use synergies of their actions.
- Promotion of waste prevention and minimisation in general should be increased to raise the awareness for this topic. This promotion should contain exemplary success stories from pilot projects, information on approaches to reach waste prevention and minimization including information on terms, possible concepts, instruments, etc. This part could either be integrated as additional part into the promotion of Environmentally Sound Management (ESM) or it could be content of a COP to get politicians involved. They could further act as multipliers to spread the information.
- A possibility to emphasis the importance of terminology is the integration of a glossary in each publication of the Basel Convention.

An essential point is, that the improvement of waste prevention and minimisation is not just an implementation but rather an integrated process in line with existing processes for waste prevention and minimisation or sustainability.

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Annex

Annex 1: Waste management hierarchies [OECD 1998A]

	Hierarchy exists		Waste prevention over recycling			On-site over off-site recycling			Reduction of hazardous amount			Material recycling over energy recovery			Recycling/ recovery over landfilling		
	Yes	No	Yes	No	=	Yes	No	=	Yes	No	=	Yes	No	=	Yes	No	=
Australia	X		X			X			X			X			X		
Austria	X		X			X			X			X			X		
Canada	X		X			n.a.				X		X			X		
Czech Republic	X		X					X			X	X			X		
Denmark	X		X			X					X	X			X		
Finland	X		X					X			X	X			X		
France	X		X					X	n.a.					X	X		
Germany	X		X					X			X			X	X		
Hungary	X		X					X	X			X			X		
Italy		X[1)]	X			X				X		X			X		
Japan	X		X			X					X	X			X		
Korea	X		X			X			X					X	X		
Netherlands	X		X			X					X	X			X		
New Zealand	X		X					X			X	X			X		
Norway	X		X					X		X				X	X		
Poland	X		X			X			X			X			X		
Spain	X		X			X			X			X			X		
Switzerland	X		X				X				X			X	X		
Turkey	X		X				X				X	X			X		
United Kingdom	X		X				X				X			X[2)]	X		
United States	X		X			X					X	X			X		
Total	**20**	**1**	**21**	**0**	**0**	**10**	**3**	**7**	**6**	**3**	**11**	**15**	**0**	**6**	**21**	**0**	**0**

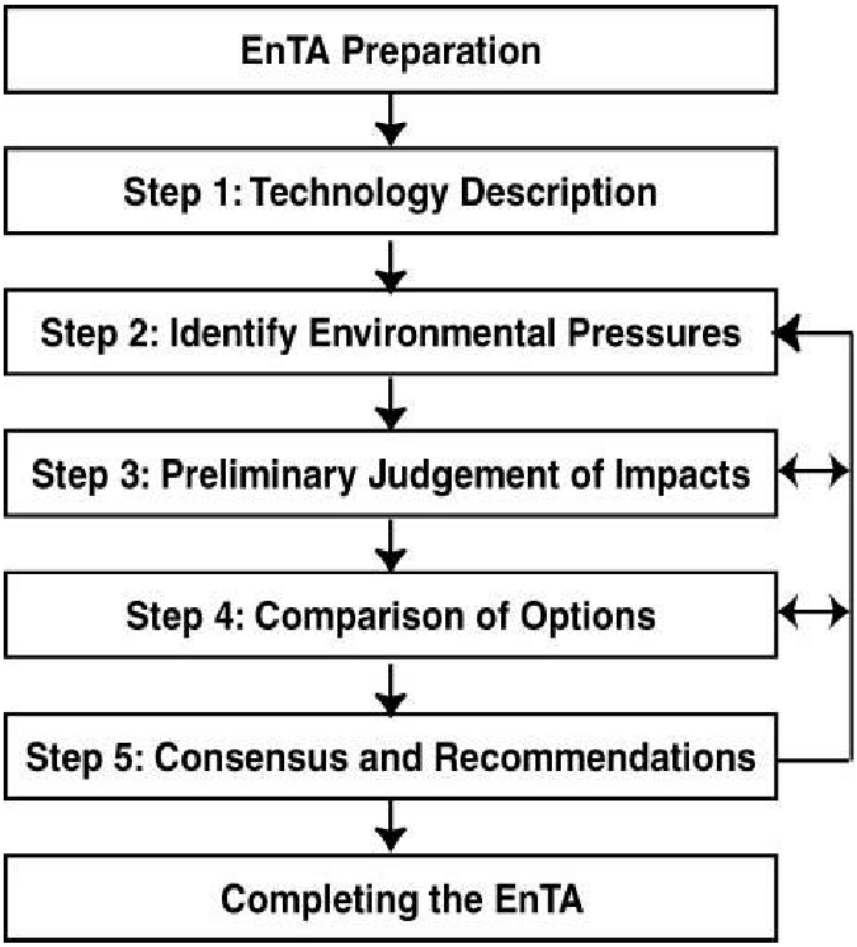
n.a.: no answer; =: same priority

[1)] A hierarchical structure is applied according to the understanding of waste minimisation in that country.

[2)] Case-by-case evaluation is based on Best Practicable Environmental Option (BPEO).

Annex 2:

Description of the Environmental Technology Assessment approach [HAY 2004]



Annex 3:

Exemplary overview on instruments implemented in various countries [OECD & EEA 2003]

Country	Taxes	Fees/Charges	Deposits/Refund	Subsidies	Voluntary Approaches
Albania		Municipal waste user charge	Deposit-refund system for glass		
Australia	Oil recycling levy	Waste levy	Deposit-refund system for beverage containers	Cleaner Production Project • Waste Management Accounting Project	• Accredited Licensee System • Environment Improvement Plans • Landfill levies • Load based licence scheme • Sustainability Covenants
Austria	Waste deposit levy	Charge on • batteries • municipal waste collection/ treatment • packaging	• Deposit-refund system for electric bulbs • Deposit-refund system for plastic bottles	Subsidies for abating air pollution, hazardous waste, and noise (except traffic)	
Belgium	Eco taxes	Charge on waste dumping and burning		PRESTI programme – Prevention Stimulation for Industry	Covenants on • batteries and storage batteries • discarded electric and electronic apparatus • old and expired medicines • paper waste • wrecked cars and old tyres
Bosnia-Herzegovina		Municipal waste user charge			
Bulgaria		• Municipal waste user charge • Product charge on tyres	Deposit-refund system for glass	• National Environmental Protection Fund • National Trust EcoFund	

Country	Taxes	Fees/Charges	Deposits/Refund	Subsidies	Voluntary Approaches
Canada	Tax on • tyres • batteries • air conditioner • non-deposit containers • alcoholic beverage container	• Charge of discharge Charge on • paint and paint-containers • municipal waste	Deposit-refund system for • all beverage containers • beverage containers (excl. milk) • beer and soft drink bottles	Subsidy for tyre recycling	• Milk Container Recycling Program • Canadian Pesticide Container Management Program • Environmental Performance Agreements • Milk Packaging Stewardship Agreement • Recycling Program for Rechargeable Batteries
Croatia		• Waste disposal charge • Waste non-compliance fees • Waste user charge	Deposit-refund system for glass		
Czech Republic	Waste deposit fee	Charge on municipal waste collection/ treatment	Deposit-refund system for glass and PET bottles	Support for ISO certification and EMAS introduction	• Eco-labelling system • Eco-Management and Audit Scheme (EMAS) • Voluntary agreement on packages

Country	Taxes	Fees/Charges	Deposits/Refund	Subsidies	Voluntary Approaches
Denmark	Duty on • carrier made of paper, plastics etc. • certain retail containers • disposable tableware • electric bulbs and electric fuses • polyvinyl chloride and phatalates • sealed NiCd-batteries • tyres • waste	Charge on • batteries • hazardous waste • municipal waste collection/treatment	Deposit-refund system for • beverage and PET bottles • lead and accumulators (batteries) • NiCd-batteries	General subsidy for integrated product policy	Agreement on • collection and recycling of old car tyres • collection and removal of lead accumulators • disposal of CGC-containing refrigerators • recycling of packaging and containers used for transport • selective demolition
Estonia	Excise tax on packaging materials	• Charge on municipal waste collection/ treatment • Waste disposal charge • Waste disposal non-compliance fees		Environmental Investments Centre (EIC) Foundation	Negotiated agreements on the management of certain types of hazardous wastes
Finland	• Oil damage levy • Oil waste levy • Soft drinks surtax • Surtax on alcoholic beverages • Tax on waste	Charge on • hazardous waste • municipal waste collection/treatment • nuclear waste • tyres	Deposit-refund system for • car hulks • soft drinks, beer, wine, spirit containers	• General subsidy for environmentally sound technology and products • Soft loans for industry and municipalities for pollution control	
France	Taxe générale sur les activités polluantes	Charge on • municipal waste collection/treatment • waste disposal			

Country	Taxes	Fees/Charges	Deposits/Refund	Subsidies	Voluntary Approaches
FYR of Macedonia		• Municipal waste user charge • Waste disposal charge			
Germany[4]	• Eco tax • Motor vehicle tax	• Municipal waste user charge • Charge on dangerous waste • Agreement on environmentally sound management of end-of-life vehicles	Deposit-refund system for beverage bottles	• Subsidy and loans for reduction of negative environmental impacts • Renewable energy Source Act (EEG) • General subsidy for environmentally sound technology and products • Programme for supporting renewable primary products	Agreement on • collection and recycling of used graphic paper • recycling and disposal of construction waste
Greece		Charge on • municipal waste collection/treatment • waste disposal			
Hungary	Product charge on • packaging materials • refrigerators and refrigerants • tyres Toxic waste levy	Charge on • hazardous waste • municipal waste collection/treatment • waste disposal Product charge on batteries	Deposit-refund system for glass and plastic bottles		
Iceland	• Hazardous waste fee • Recycling charge		Deposit-refund system for bottles, aluminium cans, plastic containers		

[4] updated: February 2004

Country	Taxes	Fees/Charges	Deposits/Refund	Subsidies	Voluntary Approaches
Italy	• Consumption tax on lubricant oil Tax on • plastic bags • waste disposal	Charge on • batteries • lubricant oil • municipal waste collection/ treatment • packaging			• Memorandums of Understanding • Programmatic agreements • Voluntary agreements
Japan		Charge on municipal waste collection/ treatment		Accelerated depreciation for investments in recycling equipment	
Korea		• Volume-based collection fee for municipal waste • Waste deposit-refund • Waste disposal charge	Deposit-refund system for • food, drink, insecticide and cosmetic containers • tires, home appliances, batteries, lubricants and fluorescent lamps Soft loans • for fostering recycling industry • from the Environmental Improvement Fund • Subsidy for environmental technology R&D • Tax credit for investments in environmental facilities and equipments		• Certification for use of environmental seal • Designation of environmentally friendly companies • Green building certification • Voluntary environmental management agreements

Country	Taxes	Fees/Charges	Deposits/Refund	Subsidies	Voluntary Approaches
Latvia		Charge on • batteries • CFCs/halons • disposable plastic tableware • light bulbs • lubricants • oil filters • packaging materials • tires • Waste disposal charge • Waste disposal non-compliance fees • Waste user charge			Green point programme – packaging and packaging waste
Liechtenstein		Charge on • glass beverage packings • waste disposal			
Lithuania		• Waste disposal non-compliance fees • Waste user charge	Deposit-refund system for beverage containers	Environmental Investment Fund	
Mexico			Deposit-refund system for • beer and soft drink containers • car batteries		
Netherlands	• Minerals accounting system • Waste tax	Municipal waste charge	Deposit-refund system for bottles for beer, soft drinks, milk and dairy products	• Grants for clean products • International co-operation • LIFE • Support for fishing industry • Support to environment and technology research	Covenant for the basic metals sector

Country	Taxes	Fees/Charges	Deposits/Refund	Subsidies	Voluntary Approaches
Norway	• Basic tax on non-refillable beverage containers • Product tax on beverage containers Tax on • final treatment of waste • lubricating oil	Charge on municipal waste collection/ treatment	• Deposit-refund system on beverage containers Refund scheme of the tax on • TRI (trichloroethene) • waste oil		Voluntary agreement on • collection and proper handling of EE-waste • the collection of windows containing PCB
Poland	Excise tax on plastic packaging	Charge on industrial waste	Deposit-refund system for • glass and plastic bottles • lead-acid accumulators • toxic chemicals packages	Grants and soft loans from debt for environment swap scheme – ECOFUND foundation	
Romania		• Municipal waste user charge • Waste non-compliance fees	Deposit-refund system for glass		
Slovak Republic		Charge for • deposition of waste to landfills • deposition of waste to sludge basins • Local charge for management of municipal waste • Product charge for recycling and waste management • Waste user charge	Deposit payments for motor vehicles	• Environmental Grant Scheme • Financing of ISPA Projects • Subsidies of environmental purposes • Environmental Development Fund	• Eco-labelling scheme • Environmental Management Systems according to ISO 14000

Country	Taxes	Fees/Charges	Deposits/Refund	Subsidies	Voluntary Approaches
Sweden	• Charge on nuclear waste • Tax on waste	• Battery fee • Charge on municipal waste collection/ treatment • Fee for scrapped cars • Fee on imported aluminium cans	Deposit-refund system for • glass and PET bottles, aluminium cans • motor vehicles	Grants for handling ship oil wastes	
Switzerland	Tax for remediation of contaminated sites	• Charge on municipal waste collection/ treatment • Disposal fee on refrigerators Prepaid disposal fee for • glass bottles • packaging Prepaid fee on • batteries • motor vehicle and tyre disposal		Support for waste incinerators, landfills and wastewater treatment plants	
Thailand[5]	• Tax differentiate, e.g. different excise tax rate for recyclable batteries which is rebated 5% of the excise tax for unleaded gasoline • Tax exemption, e.g. equipment for the control, treatment or elimination of pollutants		Deposit refund system for products containing hazardous substances such as dry cell batteries	Environmental Fund for environmentally sound management activities	

[5] SBC 1999, pp.26.

Country	Taxes	Fees/Charges	Deposits/Refund	Subsidies	Voluntary Approaches
Turkey			Deposit-refund system for glass, metal, laminate and plastic containers		
United Kingdom	Landfill tax				Packaging Waste Recovery Note and Packaging Waste Export Recovery Note System
United States	• Motor fuels tax • Waste tyre fee • Solid waste management fee • Landfill closure and contingency tax • Litter control tax • Spill compensation and control tax	Charge on • hazardous waste • municipal waste collection/ treatment • solid waste • tyres	Deposit-refund system for • beer and soft drink containers • containers of pesticides for restricted use • lead-acid batteries • vehicles tyres	• Grants and loans for recycling • Soft loans for investments in pollution control and waste disposal	