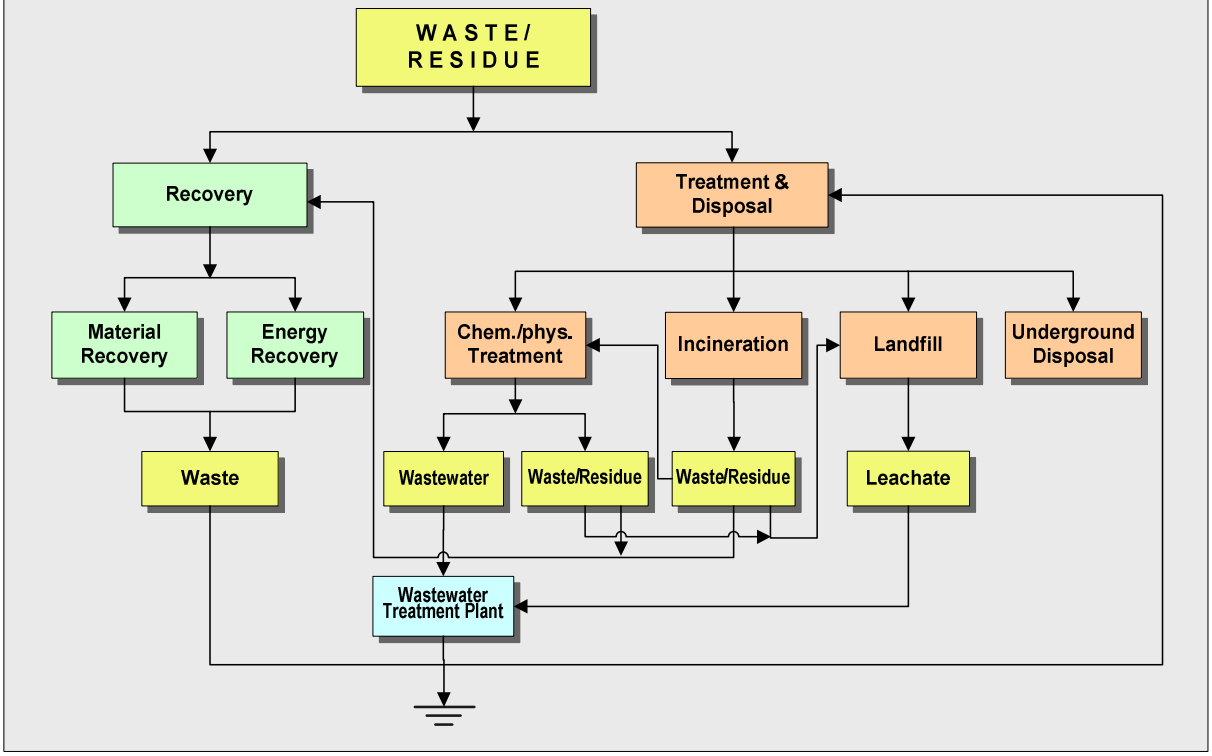

- **Module 1**
- **Hazardous Waste Generation, a summary**
- **Basic Policy Principles of Adequate Waste Management**

giz CHS Convention Project Chemical Safety

On behalf of Federal Ministry for Economic Cooperation and Development

- **Waste types and hazardous waste generation - Summary**

The following types of waste can be distinguished, depending on the source of the generated waste:

1. Municipal solid waste
2. Construction and demolition waste
3. Industrial waste (industrial non-hazardous waste, industrial hazardous waste)
4. Healthcare waste (from clinics and hospitals)
5. Sewage sludge (from Waste Water Treatment Plants)
6. Agricultural waste

In general, construction and demolition waste constitutes the largest part (up to 60% of all generated waste), but the disposal thereof is less dangerous compared to municipal or industrial waste.

The volume of municipal solid waste generation varies in industrial countries (Poland approx. 300 kg per capita per year, Germany about 500 kg per capita per year, U.S. approx. 800 kg per capita per year). The generation in developing countries is much lower (100 – 300 kg per capita per year) but increases in rapidly growing mega cities.[6]

Agricultural waste mainly hazardous pesticides as well as their containers originate from agricultural activities. Obsolete pesticides and their disposal[7] already present a great challenge to many countries.

Industrial waste is waste generated by factories and industrial plants. The larger part of industrial waste is not dangerous but a certain fraction of waste generated by industry may fulfill all criteria for hazardous waste (e.g. the properties defined as hazardous by legislation) and is subject of concern. However, the parameters for classifying waste as hazardous or non hazardous vary

throughout the world. The special properties of hazardous waste make it more difficult to deal with than with non-hazardous waste.

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[6] See HOLCIM/GIZ training module on municipal solid waste management at: http://www.coprocem.com/trainingkit/pages/module2.html

[7] See Practical Guideline on Environmentally Sound Management of Obsolete Pesticides at: http://www.basel.int/DNNAdmin/AllNews/tabid/2290/ctl/ArticleView/mid/7518/articleId/214/Practical-Guideline-on-Environmentally-Sound-Management-of-Obsolete-Pesticides-in-the-Latin-America-and-Caribbean-Countries.aspx

Industrial hazardous waste is only a part of the waste generated by societies and a comprehensive waste management system also needs to address any other waste streams, namely municipal solid waste[8], agricultural waste, sewage sludge and construction and demolition waste.

Sewage sludge is relevant in countries with functional wastewater treatment infrastructures[9]. Still there are big challenges to solve regarding the safe disposal of hazardous sludges from sewage.
Especially industrial hazardous waste has a high risk and danger to human health and the environment and if not managed in a sound manner, it can become a problem to future generations. This manual will mainly deal with industrial hazardous waste management.

1.1. Main types of hazardous waste

In general, hazardous waste is any waste or combination of waste which may cause detrimental effects to environment or human health because of its specific nature.

Hazardous waste can be found in different waste fractions defined by their origin e.g. the household waste, the commercial and industrial waste, waste from hospitals, waste from agricultural activities, etc. Artisanal mining activities produce important amounts of hazardous wastes. In the next sections we will discuss hazardous waste from health care facilities and from industry.

1.1.1. Healthcare waste (HCW)

Waste from hospitals can be extremely hazardous. Therefore, focus has to be laid on their disposal, especially under the aspect of hygiene (to prevent spreading of infectious diseases). Furthermore, healthcare waste management incorporates observing basic principles of occupational health and safety as well as ethical concerns.

According to the European Waste List (EWL), wastes stemming from hospitals and similar institutions can be very diverse and can have up to 40 individual waste constituents in some cases.

[8] See Solid Waste Management - A key to public health and environmental protection http://www.gtz.de/de/themen/umwelt-infrastruktur/abfall/27769.htm
[9] http://ec.europa.eu/environment/waste/sludge/index.htm

The following table from the EWL lists wastes that form part of the spectrum of health care wastes, the particularly hazardous waste types being marked with an asterisk (*).

EWL code	Description
18 01	**Wastes from natal care, diagnosis, treatment or prevention of disease in humans**
18 01 01	Sharps (except 18 01 03*)
18 01 02	Body parts and organs including blood bags and blood preserves (except 18 01 03*)
18 01 03*	Wastes whose collection and disposal is subject to special requirements in order to prevent infection
18 01 04	Wastes whose collection and disposal is not subject to special requirements in order to prevent infection (for example dressings, plaster casts, linen, disposable clothing, diapers)
18 01 06*	Chemicals consisting of or containing dangerous substances
18 01 07	Chemicals other than those mentioned in 18 01 06
18 01 08*	Cytotoxic and cytostatic medicines
18 01 09	Medicines other than those mentioned in 18 01 08
18 01 10*	Amalgam waste from dental care

The different types of wastes mentioned here are to be kept separately as far as possible by being discarded in separate receptacles adequate for the characteristic qualities of the waste. The sorting of the wastes should be carried out at the original place of formation, e. g. in the operating theatre, the treatment room or the sickroom.

Pointy or sharp items like knives, syringes, so-called “sharps” (scalpels, hollow needles / cannulae of syringes and infusion systems) etc. are to be placed in containers that cannot be pierced. For the other types of hazardous health care waste, special type-examination tested receptacles have to be provided additionally, in which the different types of waste can be safely stored and sealed. These containers have to be labelled accordingly. Specialised staff has to carry out the further transport of these containers. Infectious wastes (or the containers), in particular, strictly have to be prevented from being opened, decanted or otherwise handled inappropriately in the course of transportation. Safety directions / procedures have to be observed and followed for the transportation to the disposal facility. This may imply, in the case of infectious wastes, that they may only be transported in specific, type-examination tested containers, which in turn have to be labelled accordingly.

Healthcare wastes must be disposed of in a safe and sound manner. Notably, thermal treatment in special facilities (incineration plants for hazardous wastes) has to be envisaged for infectious wastes. In this context, the waste has to be burnt in its respective receptacles or collecting containers. Any disposal together with normal domestic waste should be avoided wherever possible. Specifically, healthcare waste should never be dumped in landfills, deposited in garbage disposal sites, nor be treated manually or mechanically. For

further details on HCW refer to the WHO site at http://www.healthcarewaste.org/en/115_overview.html and to World Bank guidelines at http://siteresources.worldbank.org/HEALTHNUTRITIONANDPOPULATION/Resources/281627-1095698140167/Johannssen-HealthCare-whole.pdf. In this manual we will not further deepen on HCW.

1.1.2. Industrial hazardous waste

Hazardous waste mainly emanates from industrial activities, although it may differ from production process to production process. Hazardous waste generated in diverse industrial production processes can pose severe health and environmental threats. Many components of such industrial hazardous waste types have been identified as occupational carcinogens, e.g. benzene and chromium VI. In addition, other substances -like lead in metal sludges- can cause neurological dysfunction in humans or malfunction of the kidneys and the nervous system. Adverse health impacts of selected industrial hazardous waste[10] are listed here below:

Hazardous waste	Health/ impact	Generating industrial sector
Waste xylene	Eye and mucous membrane irritation Disturbances of liver and kidney function	Pulp and paper, textile, paints
Waste benzene	Cancer Blood disorder Skin irritation	Paints, paper, leather
Peroxides waste	Eye and skin irritation Lung irritation Irritation and inflammation of nose, throat, respiratory tract	Pulp and paper, textile
Waste containing lead	Neurological dysfunction in humans High blood pressure in adults Affects blood chemistry, kidney and nervous system Accumulates in some shellfish such as mussels	Lead smelting, inorganic chemical industry, iron and steel, pigments, paint
Waste containing cadmium	Cancer Kidney damage De-calcification of bone tissues Toxic to human	Textile, leather, inorganic chemical industry, iron and steel, wood preserving, dyes and pigments
Waste containing	Cancer	Metal finishing, leather/fur, paper

[10] Source: Ministry of State for Environmental Affairs, Egyptian Environmental Affairs Agency and Egyptian Pollution Abatement Project: Hazardous Waste Management – Inspection Manual, 2002

Hazardous waste	Health/ impact	Generating industrial sector
chromium VI	Chronic irritation of the respiratory system	printing, tanning, steel, chemicals manufacturing
Waste containing arsenic	Can cause cancer Skin, eye and respiratory tract	Pigments, paints, wood preserving, inorganic chemicals, leady metallurgy
Waste containing cyanide	Toxic, can cause prompt death due to respiratory arrest Can cause blindness, and damages to optic nerves and retina Affects the central nervous system Toxic to animals and aquatic organisms	Dyes and pigments, metal treatment and coating
Waste sulphuric acid	Irritating to skin, eyes and mucous membrane	Textile, inorganic chemicals, printing inks, secondary lead smelting, metal treatment
Waste sodium hydroxide	Irritating to the upper respiratory system Causes skin irritation	Textile, metal treatment
Waste halogenated solvents	Probable human carcinogen Affects central nervous system, liver, kidney or respiratory system	Organic chemical industry, textile, pesticide, dyes and pigments, paint, inks

Industrial hazardous wastes may also pollute soil,[11] air, surface water, or underground water. Underground pollutants can be carried by underground water flow. Especially dangerous are halogenated solvents that may have leaked from underground storage tanks or may have been carelessly poured on the ground.

The production of industrial hazardous wastes is mainly correlated with the use of very different hazardous chemicals. The world production of chemicals has tremendously increased in the past decades. Although 80% of chemicals are produced in only 16 countries there is almost no country which does not use chemicals or place them into circulation[12]. Further increase in chemical production is expected in the near future.

Although, it is assumed that the production of chemicals will be the highest in the OECD countries, disproportional extension of production and use of chemicals is expected in the developing countries. China is expected to be the biggest consumer and producer of chemicals by 2015.

[11] See Impact Report: Hazardous Waste Management and Contaminated Sites at: http://www.gtz.de/de/themen/umwelt-infrastruktur/abfall/27769.htm

[12] Reichl F.-X. and Schwenk M., 2004: Regulatory toxicology, health protection, environmental protection, consumer protection. 1st ed., Springer, Berlin.

Chemicals are essential in meeting the social and economic goals of the world. With total output of over $3 trillion in 2008, the chemical industry provides employment for 7 million people and supports 20 million additional jobs. [13]

The Strategic Approach to International Chemicals Management SAICM[14] was developed by a multi-stakeholder and multi-sectoral Preparatory Committee and supports the achievement of the goal agreed at the 2002 Johannesburg World Summit on Sustainable Development[15] of ensuring that, by the year 2020, chemicals are produced and used in ways that minimize significant adverse impacts on the environment and human health.

However until now, the implementation of the commitments has been uneven and insufficient globally. With the increase of the production and use of chemicals growing amounts of wastes containing hazardous waste are expected. Industrial hazardous waste management will therefore become even more important in the future.

"The chemicals industry is one of the largest sectors of the world economy, and nearly every man-made material contains one or more of the thousands of chemicals produced by the industry. While OECD countries have seen a reduction in releases from the production of chemicals, policies are needed to address releases from the use and disposal of products, which include hazardous chemicals. Adopting a science-based risk assessment approach is among the policies reviewed as a means to ensure that adverse impacts are avoided in the most cost effective manner. With the rapid increase of chemicals production in non-OECD countries, greater attention is needed to international co-operation with these governments to build capacity, share information and promote effective chemicals management globally".[16]

The decision whether waste (or a certain waste stream) is hazardous or not is to be made by legislators and/or public authorities. A common concept used is to define properties which render a waste hazardous (such as being flammable, corrosive, toxic, carcinogenic, infectious, eco-toxic, etc; however, waste produced in certain industrial practices or exhibiting certain properties may be outside the scope of a waste management regime. Some industrial discharges may also be out of scope of waste management but regulated by other regimes (waste waters by waste water legislation, industrial gas emissions by emission control legislation, radioactive waste by radioactive legislation …), whereas industrial hazardous

[13] http://www.un.org/esa/dsd/susdevtopics/sdt_pdfs/meetings2010/ss0210-chemicals/Invitation%20_Chemicals_Seminar.pdf
[14] http://www.saicm.org/index.php?ql=h&content=home
[15] http://www.un.org/esa/sustdev/documents/WSSD_POI_PD/English/POIToc.htm
[16] OECD Environmental Outlook to 2030: www.oecd.org/environment/outlookto2030

wastes may basically be submitted to hazardous waste legislation as is the case in the EU irrespective whether it occurs in solid, sludge or liquid from.

As a first broad definition, industrial hazardous waste can be understood in this manual as all waste generated by / within industry having hazardous properties. Industrial hazardous waste in this sense may be generated in different ways and may include very different types of waste: from discharges from production processes, from used chemicals… The hazardous waste can affect negatively our waters and soils if not properly managed.

1.2. Hazardous waste generation

The United Nations Statistic Division has compiled the currently available data on the worldwide generation of hazardous waste as shown in Fig. 1. The figure demonstrates that most of the Latin American, African, Middle East and Central Asian countries have no or insufficient data available on hazardous waste.

The German Federal Statistical Office[17] publishes annually data on waste generation (Fig. 2). The decrease of waste generation observed in the period between 1999 and 2005 could be achieved by the introduction of the circular economy which facilitates the recycling of end-of-life products. The increase of total waste generation in Germany was mainly due to an increase of construction and demolition waste. Hazardous waste generation remained almost constant throughout the years.

[17] http://www.statistikportal.de/statistik-portal/en/en_inhalt10.asp

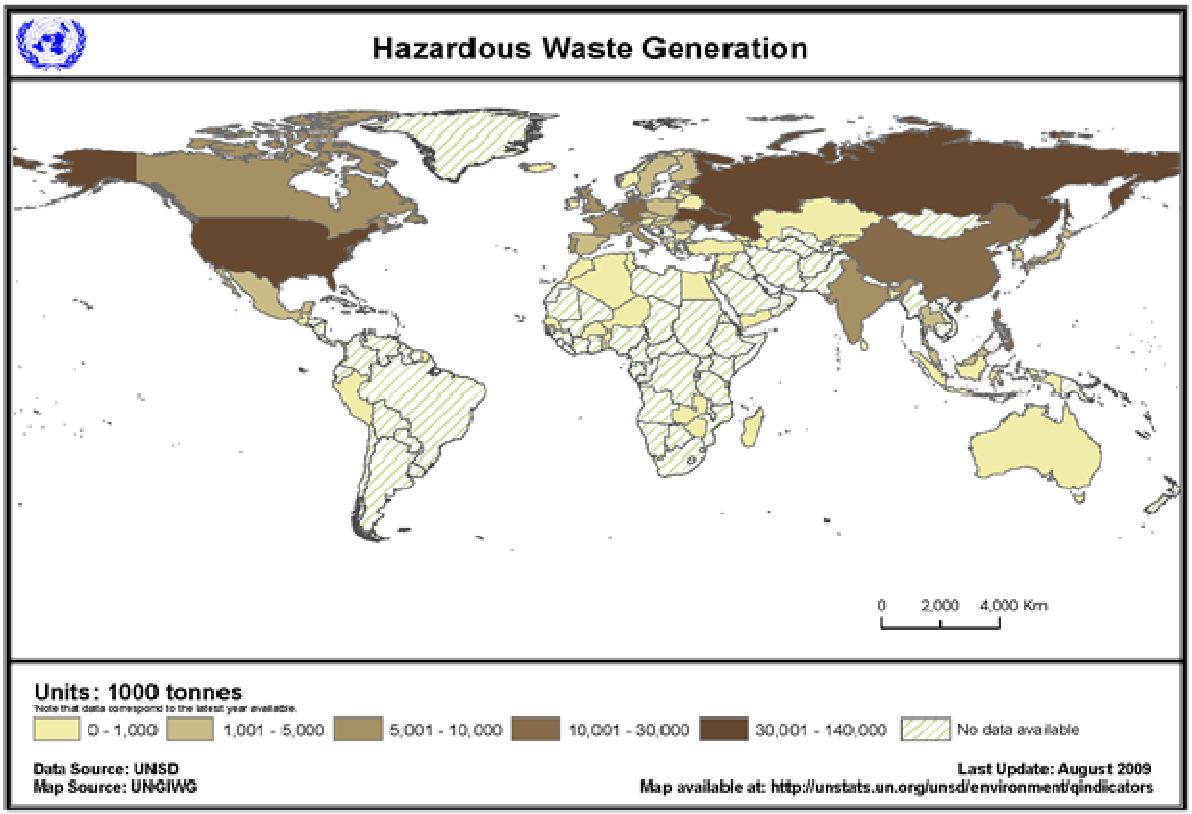

Fig. 1 Worldwide generation of hazardous waste -USA and Russia generate the greatest amounts of hazardous waste- (UNSD, 2009)

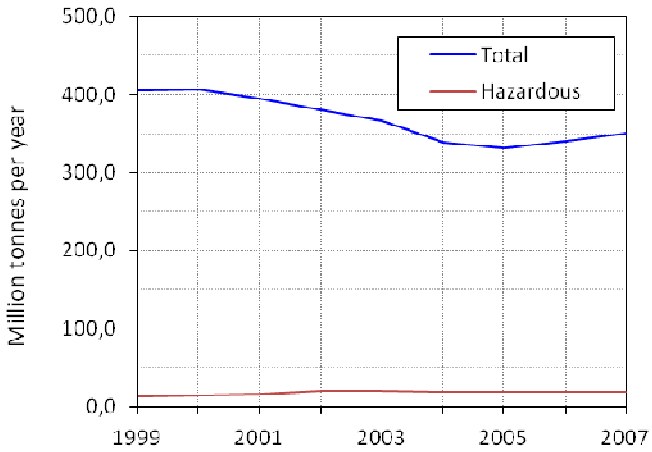

Fig. 2 Total and hazardous waste in Germany, 1999-2007 (Federal Statistical Office, 2009)

Although most of hazardous waste is generated in industrialized countries hazardous waste generation in low and middle income economies constitutes a higher danger to health and environment due to inadequate management of hazardous waste. Additionally, it is expected that in future the ratio of hazardous waste generated in industrialized and low and middle income economies will change in favor of the latter.

The Vietnamese Environmental Agency has estimated that the total amount of waste will double by the year 2010 in comparison to 2001[18] (see Fig. 3).

The amount of hazardous waste is estimated to double as well. These changes are due to high growth of the Vietnamese industrial sector. The basic industry for example, including mechanical, metallurgy, electronic and information technology and chemical industries, increased by 16.5% from 2001 to 2005[19].

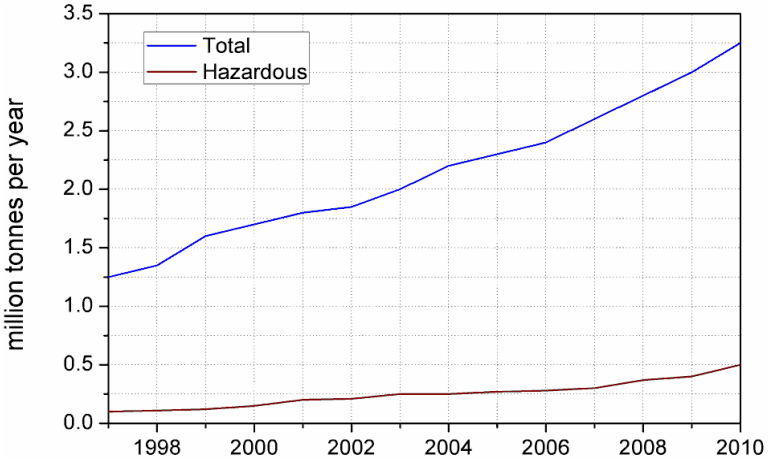

Fig. 3 Estim. of the total and industrial hazardous waste increase in Vietnam (Based on World Bank, MONRE, SIDA, 2004)

The development of waste and hazardous waste generation in Vietnam is a representative example for many low and middle income economies. It is alarming to see that in view of increasing waste and hazardous waste amounts the structures and institutions for adequately dealing with them are insufficient in many low and middle income economies.

Industrial hazardous wastes in the USA[20]

Four types of industry account for about 90% of industrial hazardous wastes generated in the United States: (1) chemical manufacturing, (2) primary metal production, (3) metal fabrication, and (4) petroleum processing.

Large chemical plants and petroleum refineries, and other "large quantity generators" that produce more than 1000 kg of hazardous wastes per month, are the most visible and heavily regulated facilities in the United States. However, businesses of all sizes generate dangerous chemicals; the EPA currently lists more than 250000 facilities as "small-quantity generators" (SQGs) of hazardous waste. These diverse, smaller producers account for about 10% of the potentially harmful substances produced each year.

[18] http://www.3rkh.net/3rkh/files/-Vietnam%20environment%20monitor-2004.pdf
[19] Duong Thai Cong (year not specified)
[20] Source: http://science.jrank.org/pages/3237/Hazardous-Wastes.html

Though large industry produces the majority of hazardous waste in the United States, the small quantity generators (SQGs) that produce between 100–1000 kg of hazardous waste per month present particular regulatory challenges: (1) The chemicals used by auto garages, dry cleaners, construction companies, scientific labs, photo developers, printers, large offices, and farmers are often toxic. (2) Hazardous wastes generated by SQGs are much more varied than those produced by large companies. Each chemical, be it a month's supply of dry cleaning fluid or a house-worth of residential insulation, requires its own handling and disposal strategy. (3) SQGs, who do not have the legal and administrative support common at large companies, often have difficulty deciphering hazardous waste regulations. Noncompliance can result from simple ignorance of a small business's responsibility to follow environmental laws.

Other sources of hazardous waste in the US are associated with military bases, mines and residential communities.

United States military bases have some of the most serious hazardous waste problems in the nation, an issue only recently addressed by government and private environmental agencies. About 19000 sites at 1800 military installations show some degree of soil or groundwater pollution. More than 90 military bases have been on the EPA's Superfund list of high-priority, hazardous waste cleanup sites. Moreover, a law passed in 1992 allows federal and state regulatory agencies to levy fines against the military if their hazardous wastes are not properly managed. Prior to this, the armed forces were not subject to state or federal environmental laws. Consequently, the military now has a range of programs to clean up hazardous waste problems at its bases.

Mining waste, a type of industrial waste, often includes hazardous substances. Mining operations commonly use hazardous chemicals, and sometimes naturally toxic substances are released into the environment during mining and the disposal of its waste materials. For example, gold mining in the Amazon Basin of South America results in the release of 90–120 tons of mercury into rivers every year. This has resulted in elevated levels of mercury in fish and humans in the region. Chemical separation of ore minerals like lead, iron, and zinc from their host rocks creates so-called acid-mine drainage that contains both the toxic chemicals used in the separation process like arsenic and sulfuric acid, and poisonous heavy metals like lead and mercury. Acid-mine drainage from metal mining in the American West has contaminated drinking water and caused serious ecological damage since the mid-1800s.

Household hazardous wastes are discarded products used in the home, which contain dangerous substances. Examples include paint, motor oil and antifreeze, drain cleaner, and pesticides. In the 1980s, many local governments in the USA and Canada began to set up regular collection programs for household hazardous wastes, to ensure that they are properly

disposed or recycled. Local or state/provincial governments usually pay the costs of such programs. However, a system used in British Columbia, Canada, requires consumers to pay an "eco-fee" on paint they buy. This, along with funds provided by the paint industry, helps pay for a collection program for waste paint from households.

Waste in the European Union

Around 3 billion tons of waste is generated in the EU each year -over 6 tons for every European citizen[21]- including 40 million tons of hazardous waste (over 10 kg per person per year).

This has a huge impact on the environment, causing pollution and greenhouse gas emissions that contribute to climate change. Good waste management can significantly reduce these impacts, and Life Cycle Thinking and Assessment (see chapter 2.5.1.) can help policy makers choose the best environmental options.

A key aim of EU policies on resources and waste is to move to a more resource-efficient and sustainable future. EU policies and legislation on waste highlight the need for good waste management.

The amount of waste is expected to increase over the coming years, because of the population growth and the progressive industrial development. For this reason an adequate waste management system has to be in place in each country to cope with these increasing waste challenges.

As example, the European Union has taken profound measures to tackle the problems of inadequate waste management and has achieved model results which can guide other countries in successful development of their waste and hazardous waste management systems.

Waste management in the EU can be understood as an approach based on three principles:

1) Waste prevention: As a key factor the amount of generated waste should be reduced

2) Recycling and reuse: If waste cannot be prevented, as many of the materials as possible should be recovered, preferably by recycling.

3) Improving final disposal and monitoring: Where possible, waste that cannot be recycled or reused should be safely incinerated, with landfill only used as a last resort.

(Source: http://ec.europa.eu/environment/waste/index.htm)

[21] http://lct.jrc.ec.europa.eu/pdf-directory/Making-Sust-Consumption.pdf

- **Basic Policy Principles with Relevance for Adequate Management of Hazardous Waste**

The following section outlines some guiding principles with relevance for waste management that should be reflected on legal acts.

2.1. The Precautionary Principle

> "Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation."
>
> UN Conference on Environment and Development 1992, Rio Declaration

The purpose of the Precautionary Principle is to create an impetus to take a decision notwithstanding scientific uncertainty about the nature and extent of the risk, i.e. to avoid 'paralysis by analysis' by removing excuses for inaction on the grounds of scientific uncertainty.

The principle involves taking precautions now to avoid possible environmental damage or harm to human health in the future. Application of this principle to hazardous waste management has concrete repercussions. For example, in case of wastes which are deemed to be potentially hazardous, such wastes should be classified, managed and disposed as hazardous waste as long as the confirmation of their hazardous or non-hazardous nature is pending or unclear. Regulators have to consider this aspect when developing hazardous waste classification systems.

2.2. The 'Duty of Care' Principle[22]

To comply with the 'Duty of Care' reasonable steps have to be taken:

1) To prevent the escape of waste whilst it is in the possession of the holder, and while it is being held by others after being transferred,
2) To provide written information which describes the waste when it is being

[22] http://archive.defra.gov.uk/search/results.htm?cx=014361324438485032053%3Aljunwq2pe_y&cof=FORID%3A11&ie=UTF-8&q=duty+of+care&siteurl=www.defra.gov.uk%2Fcorporate%2Fconsult%2Fwaste-dutyofcare%2Fstatutory-guidance.pdf#1256

transferred to another person, sufficiently well to allow them to comply with their duties,

3) To ensure that waste is only transferred to a person authorized to receive it,
4) To prevent waste causing pollution or harm, both when it is under the holder's control and subsequently under the control of those to whom the waste is transferred.

The "Duty of Care" with respect to waste management is implemented in the United Kingdom where it is being enacted under the Environmental Protection Act 1990.[23] It enhances the scope of the 'Polluter pays' principle by addressing additional stakeholders and by formulating duties specific to waste management. The "Duty of Care" enshrines in law the requirements for all producers, carriers, importers, exporters, brokers, dealers and processors of hazardous waste to manage the waste correctly by storing it properly, only transferring it to the appropriate people and ensuring that when it is transferred it is sufficiently well described to enable its safe recovery or disposal without harming the environment.

The fourth point mentioned above is of particular importance as it reminds waste generators that they remain responsible for wastes generated by them even after transfer to another party.

2.3. The 'Polluter Pays' Principle:

The costs of waste management shall be borne by the original waste producer or by the current or previous waste holders.

EU Directive 2008/98/EC, Article 14(1)

The 'Polluter Pays Principle' is a guiding ethical principle that is enacted in legislations at European, international and national levels and that applies to all types of pollution. It means that polluters should bear the full costs of the consequences of their actions. With respect to waste management the 'Polluter Pays' principle seeks to shift the responsibility dealing with waste from governments (and thus, taxpayers and society at large) to the

[23] Duty of Care, Code of Practice, UK 2009 http://www.legislation.gov.uk/ukpga/1990/43/part/II/crossheading/duty-of-care-etc-as-respects-waste

entities generating it. In effect, it internalizes the cost of waste disposal into the cost of the product, theoretically meaning that the producers will improve the waste profile of their products, thus decreasing waste and increasing possibilities for reuse and recycling.

2.4. The Cooperative Principle

The Cooperative Principle is intended to integrate all participating actors in the process of environmental decisions. This principle is indispensable for sustainable development, seeing that its holistic approach affects the complexity of production and consumption of goods as well as treatment of wasted materials and products.

> The Cooperative Principle is political and governs procedures, aiming for agreements in reaching environmental goals. Industry, citizens, environmental organizations, and science have to take responsibility. Sustainable success in environmental protection can only be achieved if everyone does their bit in their field.

2.5. The Principle of the 'Waste Management Hierarchy':

The waste hierarchy is a concept at European level that provides a preferred order of priorities for selecting and deciding upon waste management options with the aim to conserve resources and to minimize environmental damages.

> The desirable hierarchy of waste handling options is related also to sustainability. Consult the DEFRA "Guidance on applying the waste hierarchy to hazardous waste" [24] for learning more how to apply the hierarchy principle, especially reduction, reuse and recycling.

[24] http://www.google.de/url?q=http://www.defra.gov.uk/publications/files/pb13687-hazardous-waste-hierarchy-111202.pdf&sa=U&ei=2CKMT5uNM4qFhQe4kdHsCQ&ved=0CBkQFjAC&usg=AFQjCNF8Zn6VWw52FAHDYZKbQlC_Q9xR1g

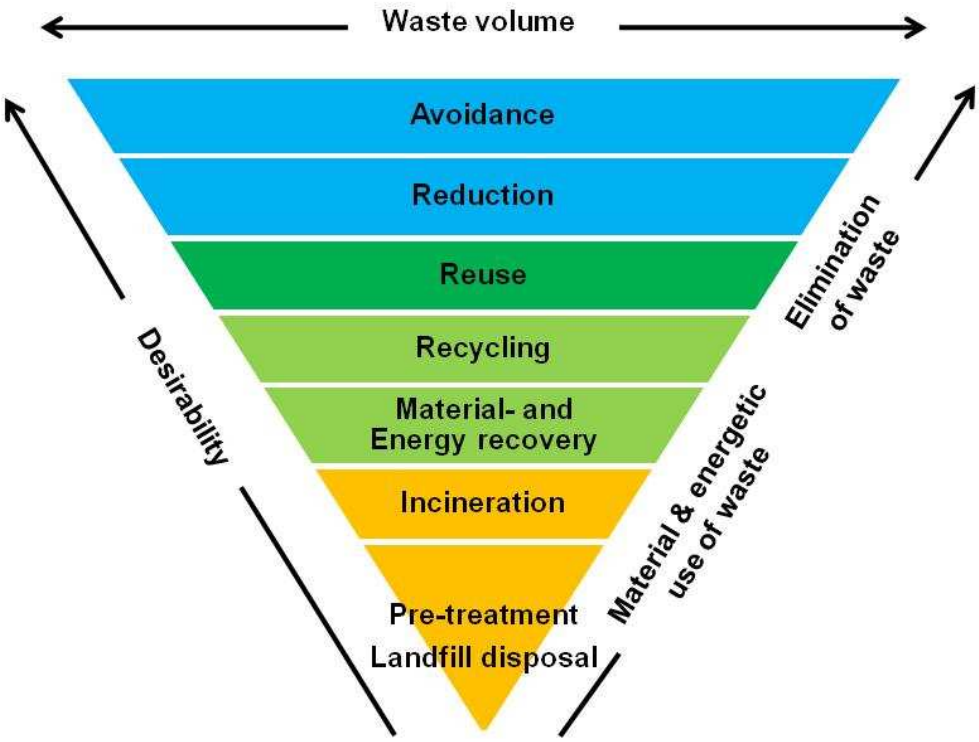

Fig. 4: Desirable hierarchy of waste handling options in relation to sustainability as seen from the EU perspective

The key options of the waste management hierarchy are explained here below:

- Waste avoidance and reduction

  Waste avoidance and reduction seek to minimize the use of resources as well as the quantities and/or hazard levels of the wastes generated at the source. Measures for achieving waste avoidance and reduction are

  - Input substitution, for reducing quantity as well as hazard level of waste
  - Increased efficiency in the use of raw materials, energy, water or land
  - Process and product design
  - Improved maintenance and operation of equipment

- Re-use

  Re-use means any operation by which products or components that are not waste are used again for the same purpose for which they were conceived

- Waste Recycling/Material and or Energy Recovery:
  - Recovery: means any operation the principal result of which is waste serving a useful purpose by replacing other materials which would otherwise have been used to fulfill a particular function, or waste being prepared to fulfill that function, in the plant or in the wider economy. Note that incineration of waste

(see below) with high energy output and backfilling operations (use of material to fill mines or for landscaping purpose) can fulfill this definition

- Recycling: means any recovery operation by which waste materials are reprocessed into products, materials or substances whether for the original or other purposes. It includes the reprocessing of organic material but does not include energy recovery and the reprocessing into materials that are to be used as fuels or for backfilling operations

It has to be noted that recovery can generate secondary wastes which again require treatment and disposal. The common approach to utilization should be to encourage the recycling business to adopt Best Available Technology (BAT) and to authorities to provide licenses to such installations only that fulfill minimum standards with regard to environment, health and safety.

- Waste Incineration, waste treatment:
  In case there is no other appropriate solution, incineration or treatment followed by landfill disposal is required in a way that causes the least harm to the environment.
  - Incineration is applied to wastes with a high content of organic pollutants. Incineration generates secondary wastes such as ash, slag, filter dusts and spent scrubber liquids
  - Chemical/physical treatment (for example evaporation, drying, calcinations, neutralization, precipitation, dewatering or encapsulation) is applied to liquid or slurry wastes for obtaining stabilized materials with defined contents and mobility of pollutants
- Waste Landfill disposal

  Final disposal is effected by disposing secondary wastes generated from incineration or treatment on secured landfill sites. Only such residues are permitted for landfill disposal that have achieved a defined level of inertness during the preceding treatment. Secured landfill sites have to meet the criteria of the 'Multi barrier Principle' which requires several barriers to be set up one independent from another to avoid release of pollutants.

2.5.1. Life Cycle Thinking and Assessment [25]

Over their life-time, products (goods and services) can contribute to various environmental impacts. Life Cycle Thinking considers the range of impacts throughout the life of a product.

[25] http://lct.jrc.ec.europa.eu/

Life Cycle Assessment quantifies this by assessing the emissions, resources consumed and pressures on health and the environment that can be attributed to a product. It takes the entire life cycle into account – from the extraction of natural resources through to material processing, manufacturing, distribution and use; and finally the re-use, recycling, energy recovery and the disposal of remaining waste.

The fundamental aim of Life Cycle Thinking is to reduce overall environmental impacts. This can involve trade-offs between impacts at different stages of the life cycle. However, care needs to be taken to avoid shifting problems from one stage to another. Reducing the environmental impact of a product at the production stage may lead to a greater environmental impact further down the line. An apparent benefit of a waste management option can therefore be cancelled out if not thoroughly evaluated.

Following the waste hierarchy will generally lead to the most resource efficient and environmentally sound choice. However, in some cases refining decisions within the hierarchy or departing from it can lead to better environmental outcomes. The "best" choice is often influenced by specific local conditions and care needs to be taken not to simply shift environmental problems from one area to another. Decision-makers need to base their choices on firm factual evidence. Life Cycle Thinking and Assessment provides a scientifically sound approach to ensure that the best outcome for the environment can be identified and put in place.

The European Commission is developing a series of technical and strategic guidance documents based on life cycle thinking to complement the waste hierarchy. These guidance documents help quantify the environmental and health benefits, as well as the trade-offs, that are associated with options for waste prevention, recycling, re-use, and energy recovery (waste hierarchy).[26]

2.6. The Principle of 'Extended Producer Responsibility':

The Member States may take legislative or non legislative measures to ensure extended producer responsibility.EPR is expressed among others by actions as for example:

- Acceptance of returned products
- Design of products reducing environmental impacts and generation of waste

[26] http://lct.jrc.ec.europa.eu/assessment/publications and http://www.oecd.org/document/19/0,3746,en_2649_34281_35158227_1_1_1_1,00.html

during the production process and subsequent use of the product

- Provision of publically available information as to the extent to which the product is reusable and recyclable

The principle of 'Extended Producer Responsibility' implies that designers, manufacturers, importers, distributors and retailers of products that give rise to the generation of wastes, should take (collective) responsibility for those wastes, rather than expecting the community to bear the burden. Responsibility should be taken for:

- Minimizing waste generated by them
- Designing and developing goods that are inherently re-usable or recyclable and do not contain materials that pose an unnecessary risk or burden for the environment
- Developing markets for the re-use and recycling of the goods they produce.

There are two key features to an EPR policy: on the one hand, the responsibility for a product in its post consumption phase is shifted upstream in the production consumption chain, to the producer, and secondly, providing incentives to producers to incorporate environmental considerations into the design of their products.

By putting the responsibility and economic burden of waste management on the producer, EPR can constitute a key element to set incentives for waste prevention for the appropriate actors.

2.7. The Principle of 'Waste Management Self-sufficiency':

Waste management self-sufficiency should be achieved on a regional or national level and in particular, if possible, on the Member State's level of a political or economic union. To this end, Member States will have to establish, possibly in co-operation with other Member states, an integrated and adequate network of waste utilization and disposal facilities.

This principle aims at stopping the misuse of economical gaps between different regions for exporting waste from high income to low- and middle income countries.

2.8. The Proximity Principle:

Wastes should be treated or disposed of as close to their source of generation as possible

The proximity principle means that waste should be treated and/or disposed of as near as possible to the point where it arises. This principle aims to avoid the adverse environmental impacts of unnecessary waste transport. However, the environmental impacts of transporting wastes very much depend on local conditions and circumstances.

The application of the principle will therefore vary according to the type of waste concerned, the quantity, the potential hazard and the potential environmental impact of the method of

waste treatment/disposal and the mode of transport. *There also has to be a balance between the proximity principle and economy of scale*[27]. In certain cases, economy of scale means that some specialist treatment, recovery or disposal operations may be located far from the point where the waste is generated.

2.9. The Principle of 'Best Available Technique' (BAT):

According to the European Integrated Pollution Prevention and Control (IPPC) Directive (http://ec.europa.eu/environment/air/pollutants/stationary/ippc/index.htm) emissions from installations to the environment should be reduced to the most possible extent and economically in the most efficient manner. The European IPPC Bureau (located in Seville, Spain) provides Best Available Techniques Reference Documents (BREFs)[28] compiled for various industrial branches, e.g. for "Surface treatment of metals, or "Tanning of hides and skins". Although primarily elaborated for purposes at EU level, BREF are a useful tool to assess the state-of-the-art of environmental sound technology. The information contained in the BREFs can help to evaluate what is technically and economically achievable in terms of best environmental performance within waste management facilities

List of 33 BREF documents published at http://eippcb.jrc.es/reference

Waste policy is based on:

- Precautionary principle
- Polluter pays principle

[27] **Economy of scale**, in microeconomics is the cost advantages that a business obtains due to expansion. They are factors that cause a producer's average cost per unit to fall as scale is increased. Economy of scale is a long run concept and refers to reductions in unit cost as the size of a facility, or scale, increases.

[28] http://eippcb.jrc.es/reference

- Duty of care principle
- Cooperative principle
- Waste management hierarchy principle
- Extended Producer Responsibility principle
- Waste management self-sufficiency principle
- Proximity principle
- Standards for best available techniques

These fundamental principles may serve as a good starting point for low and middle income economies interested in developing and/or improving their own HWM systems. Whereas industry largely has impacts on waste generation and waste management, the responsibility and costs of appropriate waste management are primarily on the shoulders of the competent authorities and the general public, because there are no other incentives for the producing industry to change to less impacting products.

In order to change this situation and to foster sustainable innovation in industrial production, the introduction of the polluters pay principle is paramount. The most ambitious approach in this field is to establish and extended producer responsibility (EPR). This constitutes a political approach in which the producer's financial and/or physical responsibility for a product is extended to the post consumer stage of the product's life cycle.It specifically focuses on reducing the environmental impacts of a product in the post consumer phase.

2.10. Lessons learnt of German International Cooperation in the Field of Waste Management [29]

The German Federal Ministry for Economic Cooperation and Development (BMZ) is in charge of financing and providing orientation for the cooperation with partner countries[30]. This is achieved in part through its financial and technical instruments, supporting peaceful solutions for crises and conflicts, helping to improve in a fairer way the distribution of resources and to preserve the resources for future generations. The overall aim is to increase the amount of people having a share in the prosperity. This cooperation focuses on selected thematic fields related e.g. to poverty alleviation, good governance, sustainable development, and among others waste management, including hazardous waste.

[29] "BMZ Strategiepapier 3, Ressource Abfall 2012
http://www.bmz.de/de/publikationen/reihen/strategiepapiere/Strategiepapier317_3_2012.pdf

[30] Afghanistan, Albania, Algeria, Angola, Armenia, Azerbaijan, Bangladesh, Benin, Bolivia, Bosnia and Herzegovina, Brazil, Burkina Faso, Burundi, Cambodia, Cameroon, China, Colombia, Costa Rica, Côte d'Ivoire, Cuba, Democratic Republic of the Congo, Dominical Republic, Ecuador, Egypt, El Salvador, Ethiopia, Ghana, Georgian Republic, Guatemala, Guinea, Haiti, Honduras, India, Indonesia, Jordan, Kenya, Kosovo, Kyrgyzstan Laos, Lebanon, Liberia, Madagascar, Mali, Malawi, Mauritania, Mexico, Moldova, Mongolia, Montenegro, Morocco, Mozambique, Namibia, Nepal, Nicaragua, Niger, Nigeria, Palestinian Territories, Pakistan, Paraguay, Peru, the Philippines, Rwanda, Zambia, Senegal, Serbia, Sierra Leone, South Africa, Sri Lanka, Sudan, Syria, Tajikistan, Tanzania, Tunisia, Uganda, Ukraine, Uzbekistan, Vietnam, Yemen

Development of waste management systems contributes to the preservation of human health and environment, especially of the climate, the biodiversity and the water. It helps to establish a proper functioning urban infrastructure, facilitates good governance, improves economic conditions, and boosts secondary raw material and alternative energy supply. The main principles of the German assistance in waste management is to efficiently use raw materials and to minimize waste generation where possible, to use waste as a resource where appropriate, and to diminish the negative impacts on the human health and the environment of the waste handling processes.

BMZ supports the activities of waste management in partner countries and thus focuses on advisory and strengthening strategic planning, establishment of legal basis, creation of relevant institutions, selection of appropriate waste handling techniques, instruments of finance and cost recovery, diffusion of the circular economy, participation of and cooperation with the private and the informal sectors as well as with all other stakeholders.

Experience from both industrial and developing countries has shown that the way to manage waste as a resource is the result of a process involving five phases and cannot be achieved in only one step. These five phases show the different levels of the development of the appropriate waste management system, as is shown in Fig. 5.

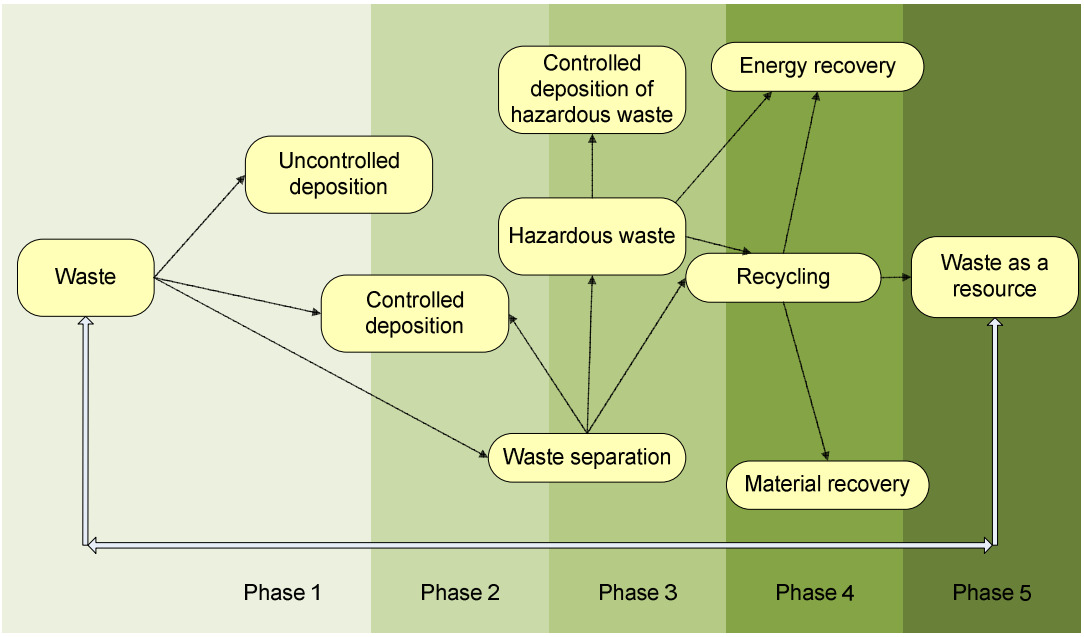

Fig. 5: Phases of waste management development (Source BMZ Resource waste, 2012)

Adequate handling of hazardous waste is an integrated part of the waste management system. It therefore cannot be considered separately but must be treated as an issue which

is connected to other fields and aspects of waste management, including both technical and non-technical matters.

Table 1 describes the fields of waste management activities characteristic of each of the five phases. However, the chronological sequence and the temporal length of each phase may vary from region to region depending on the environmental policy and the economic conditions of the respective area.

Table 1: Waste management development phases. The chronological sequence and the temporal length of each phase may vary from region to region depending on the environmental policy and the economic conditions of the respective area

Fields of waste management activity	**Phase 1:** Establishment of waste collection	**Phase 2:** Optimization of collection; Introduction of controlled land filling	**Phase 3:** Introduction of separate collection of valuable material and hazardous waste	**Phase 4:** Optimization of recovery potentials and waste treatment	**Phase 5:** Circular economy, waste as a resource
Collection	Collection of waste for the purpose securing the sanitation	Increase of collection rates	Beginning of separate collection of valuable material and hazardous waste	Efficiency optimization of the collection systems and further differentiation of waste collection	Alignment of the collection systems with the requirements of the circular economy
Recovery	Recovery carried out by the informal sector and private companies (without public funding)	Recovery carried out by the informal sector (waste picking) and private companies (without public funding)	Introduction of instruments for enhancement of recovery and recycling (deposit systems, subsidies, regulations on recyclable products)	Systematic identification of recovery potentials	Total recovery of waste
Treatment	Non	Non	Simple systems of recovery (shredding, sieving, composting), separate treatment of hazardous waste	Complex systems of waste treatment (bio-mechanical treatment, thermal treatment), no land filling without pretreatment	Total recovery of valuable material and reintroduction into the production cycle
Land filling	Open uncontrolled dumping sites	Dumping at appropriate sites with precautionary measures during the landfill operation	Land filling with treatment of leakage water, gas collection and use of gas, recultivation and renaturation	Restriction of land filling to inert waste	No land filling

2.11. Adequate Management of Hazardous Waste

The management of hazardous waste in a country, a region or worldwide is a complex, multidisciplinary process. Bad waste management entails serious health and environmental risks; for this reason management activities must be properly planned.

Although most hazardous waste is generated today in industrialized countries, hazardous waste generation in Low and Middle income economies constitutes a higher danger to health and environment due to often inadequate management of hazardous waste. Additionally, it is expected that in the future Low and Middle income economies will produced more hazardous wastes than the industrialized countries; **therefore waste management infrastructure and an appropriate administrative system need to be improved in these countries**.

Waste generation is determined by a number of factors such as levels of economic activity, production procedures and product design. Any product produced will become waste at the end of its life cycle. Therefore the composition and amount of products and product packaging is a crucial factor for the quantity and environmental risks of the generated waste and determines/limits the possibilities for recycling and recovery of material and energy from waste. To be successful, waste policy hence needs to be closely linked with product policy in terms of a so-called integrated product policy taking into consideration during the production phase already the full life cycle and the impacts and implications on waste generation and treatment.

Definition of waste management

In principle “Waste management” comprises any step of handling waste from the moment of its generation up to the moment of its final disposal or its re-entering into the product status by means of recycling or recovery. Accordingly, the EU Waste Framework Directive defines waste management as “the collection, transport, recovery and disposal of waste, including the supervision of such operations and the after-care of disposal sites, and including actions taken as a dealer or broker”.

Links between waste management and waste prevention and sustainable material management:

Management of hazardous waste is not an isolated task, but has to be seen in the context of the legislator’s general approach towards waste management and, moreover, with the general policy on integrated product management. Preventing the generation of waste in the first place, e.g. through the improvement of industrial processes aiming to decrease the amount of waste generated or the hazardousness of waste and its negative impacts or by facilitating the re-use of materials before they actually become

waste, should be emphasized in preference to any means of waste treatment.

Waste prevention or minimization can produce environmental benefits throughout the product life cycles. Most directly, preventing the generation of waste reduces the need for further investments and energy use to collect, store, process and dispose of what would have been waste. This translates into fewer waste collection vehicles with less air pollution and into a reduced need for waste storage space, waste processing and waste disposal.

Waste potentially contains also an increasing amount of valuable material and/or energy which is lost for the economic cycle if disposed of. In the light of increasing shortness of available resources and restrictions on the use of energy and raw material, waste management therefore should focus on resources, the best possible efficiency in recycling and recovery of substances and energy contained in the waste. Waste management should hence be closely linked with and can contribute considerably to sustainable material management.

2.12. Necessary obligations for waste management infrastructure (waste collection and treatment facilities)

Successful waste management requires certain infrastructural features such as an adequate regulatory framework and enforcement infrastructure (see recommendations in OECD Guidance Manual from 2007[31], in chapter 2.3), and the establishment of an appropriate waste separation, collection and treatment infrastructure.

This includes (apart from the definition of matter and scope), provisions and schemes for authorizations/licenses/permits, performance standards (e.g. emission limit values, construction and site standards, operational standards), monitoring and reporting obligations, environmental liability and penalties. Besides national provisions, international waste movement needs to be taken into consideration and has to be covered as well.

The enforcement mechanisms should comprise verification of compliance with legal instruments and standards, co-ordination between several government levels, information exchange, training, and incentive programs.

Establishment of the appropriate waste management infrastructure comprises planning and awareness of targeted policies in order to encourage the development of a varied and tailor-made system of environmentally sound management encouraging recycling and recovery.

[31] Guidance Manual for the Implementation of the OECD Recommendation C(2004)100 on Environmentally Sound Management (ESM) of Waste (OECD, 2007), Document available at http://www.oecd.org/dataoecd/23/31/39559085.pdf

2.13. Obligations and standards for waste treatment facilities

In addition to provisions and obligations for waste management and control infrastructure related to competent authorities, successful waste management requires obligations and standards for treatment facilities. For this purpose the OECD recommends integrating so called **Core Performance Elements (CPEs)** into national policies and/or programs to be applied at the level of individual facilities as minimum standard without discouraging recycling, in particular increasing the rates of environmentally sound recovery of low risk waste.

The OECD Guidance Manual from 2007[32] lists the following six obligatory CPEs to be complied with by waste management facilities:

1. Environmental Management System (EMS)[33]
2. Adequate measures to safeguard occupational and environmental Health and Safety
3. Adequate monitoring, recording and reporting programs
4. Appropriate and Adequate Training Program for Personnel
5. Adequate Emergency Plan
6. Adequate Plan for Closure and After-care.

2.14. Obstacles in relation to the establishment of HWM Systems and approaches for possible solutions

The development of legislation on waste management might be difficult with regard to elaborating a concise and clear legal framework on such a complex issue like waste management. However, Basel Convention and OECD provisions as well as EU legislation provide good starting points to adopt provisions on a national scale (see more details in Module 2).

Obstacles in most cases are financial or related to lack of awareness and expertise. They hence affect mainly the practical enforcement of those legal provisions for environmentally sound waste management.

Further the lack of expertise, the lack of legal framework, the lack of documentation among other factors represents mayor obstacles in the establishment of a HWM system.

According to a recent survey performed on behalf of the Basel Convention[34] it was noticed that:

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[32] Guidance Manual for the Implementation of the OECD Recommendation C(2004)100 on Environmentally Sound Management (ESM) of Waste (OECD, 2007), Document available at http://www.oecd.org/dataoecd/23/31/39559085.pdf

[33] http://www.quality.co.uk/ecoadvic.htm

- -waste prevention and minimization, recycling, recovery and disposal, the use of cleaner technologies and production, the improvement of institutional and technical capacity-building, and the development and transfer of environmentally sound technologies- are not fully implemented.

- Treatment of hazardous waste and establishment of an appropriate enforcement infrastructure is costly. According to the survey, the main obstacles in the implementation of appropriate waste management are a lack of adequate and sustainable financial mechanism (associated with difficulties in resource mobilization). This leads to an absence of proper facilities to dispose of hazardous waste as well as a lack of inadequate technology for effective hazardous waste treatment and a lack of training and awareness raising.

Cost recovery mechanisms that could be used (by companies, regional and local authorities) for investment in hazardous waste management could be one step towards solving this problem. Other approaches are product stewardships (producer responsibility schemes), and a stepwise approach starting with major hazards before expanding to the entire sector.

This manual should support competent authorities in overcoming part of these obstacles. Most of these obstacles may be tackled with the help of information and close cooperation as will be discussed in this manual on topics referring to the description of main responsibilities of the different stakeholders involved in HWM (see chapter 5.2), to the waste management planning (see module 6), to permitting and control (see module 4 and 5), and to awareness raising and support of waste producers (see module 3).

Regular information exchange, nomination of a task force and expert rounds to discuss observed problems and deficits in the field of waste management can be a successful approach. Training and awareness raising then need to be expanded to the industry and the general population.

Guidance, training, incentives and penalties are the major instruments to convince the industry to deal with the additional bureaucratic provisions and to fulfill all requirements in order to comply with legal provisions.

[34] Report on the review of the implementation of the current strategic plan, 2009 http://www.google.de/url?q=http://archive.basel.int/stratplan/report/report.pdf&sa=U&ei=3ySMT_jHGsWZhQfWxKm8CQ&ved=0CBQQFjAA&usg=AFQjCNGQuxKs7cKAuFENr-hV9CSXqQ3-dQ

In regard to waste recycling there are various market barriers and reasons for failures. Although recycling is less a matter of hazardous waste management general principles and problems do also relate to closed loop production approaches.

Nevertheless, recycling of hazardous waste especially, and hazardous metals, will play an important role in the future due to the scarcity of raw materials and the negative environmental impact during their extraction. These aspects should be considered in future raw material strategies for different countries. As an example see the German raw materials strategy under the following link: http://www.bmwi.de/English/Navigation/Service/publications,did=376156.html

Last but not least, the OECD document on recycling markets "Improving Recycling Markets"[35] which deals with common obstacles for waste oils, waste plastics, and used rubber tires, and the use of "industrial" policies complementary to more traditional environmental policies in terms of social welfare costs, is recommended as additional information source.

2.15. Where is your country in relation to an adequate Hazardous Waste Management System?

To evaluate the situation in your country you can invite key representatives from the public, private and NGO waste sector to discuss the subject and to make suggestions for improvement .This can be done during a moderated stakeholder dialogue, where it should be evaluated where your country is in relation to an adequate HWM and which steps should be taken to improve the implementation of an adequate hazardous waste management system considering also recovery, reuse and recycling policies. For discussion and documentation purposes you can use the points referred in the following box (next page) during the stakeholder dialogue as indicators for this evaluation and so described more precisely which obstacles still exist in preventing the establishment of an appropriate HWM system in your country.

Possible discussion points during a stakeholder dialogue:

- Lack of adequate and up to date legislation including sublegal acts for ESM (reduction, reuse, recycling, incineration, landfill) and enforcement mechanisms (e.g Strategic Plan and infrastructure including inter ministerial coordination and the role of regional and local authorities)

[35] Improving Recycling Markets (OECD, 2007) at: http://www.google.de/url?q=http://www.oecd.org/dataoecd/37/59/38093900.pdf&sa=U&ei=04mOT_zvGYSp0QW1nMSJDQ&ved=0CBUQFjAA&usg=AFQjCNF04DuZVn8-9Rmdd2vinUKMP9HQPg

- Lack of an effective monitoring system and implementation mechanisms to effect changes
- Lack of waste facilities for collection, treatment and disposal
- Lack of understanding and acceptance of roles and responsibilities by stakeholders (including behavior and cultural resistance to change waste management
- practices)
- Limited collaboration among agencies in the management of hazardous wastes
- Weak mechanism for information sharing among important stakeholders to facilitate decision making
- Lack of record-keeping on hazardous waste generation at the source (hazardous waste generation, quantity, physico-chemical properties, and producers of wastes)
- Lack of necessary data concerning waste production and management (hazardous waste list, inventory and identification of new hazardous waste)
- Lack of a chemicals legislation in the country similar to REACH or TSCA
- Under-utilization and improper use of practical and theoretical expertise where it may be available

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