Matthias Kühle-Weidemeier (ed.)

EU Waste Management 2010

European waste management in the view of the waste framework directive

Proceedings

Cologne, 8th – 9th of June 2010

Organiser

wasteconsult INTERNATIONAL

Gold Sponsor

ECOENERGY Environment & Energy

Cuvillier Verlag

Matthias Kühle-Weidemeier (ed.)

EU Waste Management 2010

European waste management in the view of the waste framework directive

Proceedings

Cologne, 8th – 9th of June 2010

Organiser

wasteconsult INTERNATIONAL

Gold Sponsor

ECOENERGY Environment & Energy

Cuvillier Verlag

Bibliografische Information der Deutschen Nationalbibliothek
Die Deutsche Nationalbibliothek verzeichnet diese Publikation in der Deutschen Nationalbibliografie; detaillierte bibliografische Daten sind im Internet über http://dnb.d-nb.de abrufbar.
1. Aufl. - Göttingen : Cuvillier, 2010

978-3-86955-344-3

Nonnenstieg 8, 37075 Göttingen
Telefon: 0551-54724-0
Telefax: 0551-54724-21
www.cuvillier.de

1. Auflage, 2010
Gedruckt auf säurefreiem Papier

978-3-86955-344-3

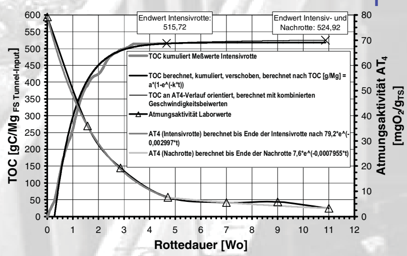
Mechanical biological waste treatment

Design engineering and optimisation of MBT plants

The staff of **Wasteconsult** is and has been significantly involved in research, plant design and optimisation of the mechanical biological waste treatment and its emission control. Based on this, we design and optimise MBT plants for you.

Pilot projects

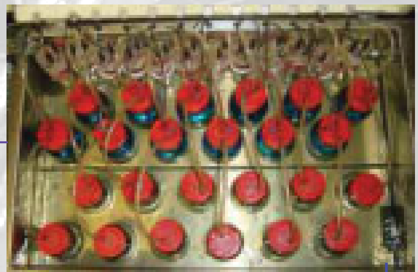
We supplement our experience by own pilot tests and research results in the area of MBT optimisation and emission measurement & treatment. We have developed and tested what others just know from books!



Sampling and analytics

Waste treatment needs a permanent control and adaption to the varying waste composition and changed boundary values.

Wasteconsult offers an extensive attendance of your MBT beginning with sampling and ending with the evaluation of the analytical results. This is a precondition for stable and economically operation of your MBT.



Emission measurement

Do you want to know what gets into your exhaust gas treatment and what is in its output? Do you want to adjust the MBT for an economically optimised operation of a regenerative thermal oxidation of the exhaust gas? We have experience with the measurement technique and accomplishment of long continous emission measurements. We can analyse your biogas from the digestion or your landfill gas for the main and trace components.

At Wasteconsult you are in best hands for design engineering, optimisation and analytics in all aspects of MBT!

Landfills and contaminated land

Design engineering

The **Wasteconsult** staff has extensive experience in the whole area of design engineering, bid invitation and construction supervision of

- Landfill covers and liners
- Operation and emplacement concepts
- Gas collection and treatment
- Leachate and groundwater collection and treatment

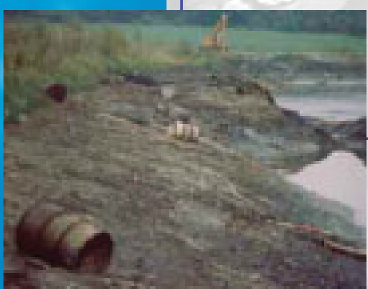
Our know how about MBT landfills is unique.

Monitoring, aftercare and reuse

Landfills and contaminated sites need a long lasting supervision. Wasteconsult designs your aftercare measures and monitors groundwater, leachate, gas and the landfill installations. Furthermore we propose possibilities for the reuse of the landfill area. Depending on the legal regulations (financial support) in your country, wind energy or photovoltaics might be an attractive solution. Our new concept **DepoSolar®** combines the function of landfill cover sealing and solar electricity production.

In-situ stabilisation

An important step to minimise the aftercare duration and costs is the active contol of closed landfill sectors. This starts with leachate re-infiltration to enhance the gas production and the anaerobical stabilisation. When the gas yield or the methane concentration are to low, the time has come for a methane oxidising cover or for the start of in-situ aeration of the landfill. This will accellerate the stabilisation of the landfill significantly and save money because of the reduced leachate contamination and the shortened aftercare phase.



Contaminated land

Based on the long lived experience of our staff we can offer the whole package of engineering services for the remediation of contaminated land:

- Site investigation and risk assessment
- Design of clean up operations
- Construction supervision & control of occupational security

Take advantage of our experience!

Content

I Introduction and overview

Address of welcome; Reduce; re-use; recycle – a global necessity. 1
Kühle-Weidemeier, M.

Future is not an extrapolation of the past (CK Prahalad) – On the way to a global resource management. 15
Birnstengel, B., Alwast, H., Haeusler, A.

The new waste framework directive and next steps in EU waste policy. 26
A. Versmann

II Current situation and implementation of the waste framework directive

Germany. 38
Jaron, A.

Belgium. 45
Wante, J.

Greece confronted with the new waste framework directive. 54
Karagiannidis, A.

Waste Management in Romania: Past and present. 61
Rada, E. C.,, Apostol, T., Ragazzi, M., Istrate, I. A.

Endeavours of Poland to reach a high standard of municipal waste management 279
Rybaczewska-Blazejowska, M.

III Avoidance and waste management concepts

Waste Producers' Duty of Care under European Community Law 73
Mott, R. M..

Optimization model of integrated MSW management. 86
Nondek, L.

Evolution and optimization of a residential source separation scheme in a 15 year history: Quality and efficiency in the North Italian experience. 98
Garaffa, C., Mariotto, L., Moriando, A., Roverato, C.

Municipal waste management in Zagreb; Vienna or Neapel model? 110
Potocnik, V.

Strategy and implementation plan for Integrated Solid Waste Management in Tehran. 122
Amir, S., Harati, N.

IV Management of special waste flows

Hazardous waste classification and re-use (end of waste) by the new waste framework directive, CLP and REACH regulations. 130
Malicka, M.

Improvement of hazardous waste management in Turkey through introduction of a web-based system for data collection and quality control. 138
Küchen, V., N.N.

DIRECT-MAT – Developing best practise on recycling of safe disposal of road materials in Europe. 151
Mollenhauer, K., Arm, M., Descantes, Y., de la Roche, C., Pihl, K. A., Gaspar, L., de Lurdes Antunes, M., De Bock, L., McNally, C.

Legal requirements and practise of the transport of healthcare waste within the European Union. 162
Brück, K., Ramalho, P.

V Recovery of plastics and other types of high calorific waste

Plastic flows from production to (optimized) recovery. 171
Fehringer, R.

Evaluation of system costs for the use of plastics with regard to disposal costs. 180
Schu, R.

North London Waste Authority – Waste Services & Fuel Use Procurement. 194
Ling, E., Judson, T.

Formula for energy efficiency – meaning and application. 209
Hauer, W.

VI Increasing energy efficiency in waste to energy processes

Increasing energy efficiency: A plant manufactures view. 216
Maciejewski, M.

Achieving a high energy efficiency at the EBS power plant Stavenhagen. 227
Plepla, K.-H.

VII Material specific waste treatment

French national household waste characterisation survey. 243
Fangeat, E.

Sensor based sorting: A key technology for sustainable waste management. 250
Pretz, T.

Comparison of methods for the treatment of mixed municipal waste from households. 259
Mitterwallner, J., Himmel, W.

Pre-processing of municipal solid waste before anaerobic digestion – CAPEX and OPEX as model calculation. 271
Langen, M.

Note

The proceedings were arranged by Wasteconsult international Dr. Kuehle-Weidemeier with high accuracy. Nevertheless, errors cannot be fully excluded. Wasteconsult and the editors are not liable or responsible for the correctness of the information in this book. The authors take responsibility for their content.

If a brand or trade name was used, there might be trademark rights valid, even if they were not explicitly stated.

The proceedings contain complicated technical terms. Wasteconsult does not take any liability for the correctness of the translation. Please check the plausibility of the content you are reading.

Content

I Introduction and overview

Address of welcome; Reduce; re-use; recycle – a global necessity. 1
Kühle-Weidemeier, M.

Future is not an extrapolation of the past (CK Prahalad) – On the way to a global resource management. 15
Birnstengel, B., Alwast, H., Haeusler, A.

The new waste framework directive and next steps in EU waste policy. 26
A. Versmann

II Current situation and implementation of the waste framework directive

Germany. 38
Jaron, A.

Belgium. 45
Wante, J.

Greece confronted with the new waste framework directive. 54
Karagiannidis, A.

Waste Management in Romania: Past and present. 61
Rada, E. C.,, Apostol, T., Ragazzi, M., Istrate, I. A.

III Avoidance and waste management concepts

Waste Producers' Duty of Care under European Community Law 73
Mott, R. M..

Optimization model of integrated MSW management. 86
Nondek, L.

Evolution and optimization of a residential source separation scheme in a 15 year history: Quality and efficiency in the North Italian experience. 98
Garaffa, C., Mariotto, L., Moriando, A., Roverato, C.

Municipal waste management in Zagreb; Vienna or Neapel model? 110
Potocnik, V.

Strategy and implementation plan for Integrated Solid Waste Management in Tehran. 122
Amir, S., Harati, N.

IV Management of special waste flows

Hazardous waste classification and re-use (end of waste) by the new waste framework directive, CLP and REACH regulations. 130
Malicka, M.

Improvement of hazardous waste management in Turkey through introduction of a web-based system for data collection and quality control. 138
Küchen, V., N.N.

DIRECT-MAT – Developing best practise on recycling of safe disposal of road materials in Europe. 151
Mollenhauer, K., Arm, M., Descantes, Y., de la Roche, C., Pihl, K. A., Gaspar, L., de Lurdes Antunes, M., De Bock, L., McNally, C.

Legal requirements and practise of the transport of healthcare waste within the European Union. 162
Brück, K., Ramalho, P.

V Recovery of plastics and other types of high calorific waste

Plastic flows from production to (optimized) recovery. 171
Fehringer, R.

Evaluation of system costs for the use of plastics with regard to disposal costs. 180
Schu, R.

North London Waste Authority – Waste Services & Fuel Use Procurement. 194
Ling, E., Judson, T.

Formula for energy efficiency – meaning and application. 209
Hauer, W.

VI Increasing energy efficiency in waste to energy processes

Increasing energy efficiency: A plant manufactures view. 216
Maciejewski, M.

Achieving a high energy efficiency at the EBS power plant Stavenhagen. 227
Plepla, K.-H.

VII Material specific waste treatment

French national household waste characterisation survey. 243
Fangeat, E.

Sensor based sorting: A key technology for sustainable waste management. 250
Pretz, T.

Comparison of methods for the treatment of mixed municipal waste from households. 259
Mitterwallner, J., Himmel, W.

Pre-processing of municipal solid waste before anaerobic digestion – CAPEX and OPEX as model calculation. 271
Langen, M.

Endeavours of Poland to reach a high standard of municipal waste management 279
Rybaczewska-Blazejowska, M.

Note

The proceedings were arranged by Wasteconsult international Dr. Kuehle-Weidemeier with high accuracy. Nevertheless, errors cannot be fully excluded. Wasteconsult and the editors are not liable or responsible for the correctness of the information in this book. The authors take responsibility for their content.

If a brand or trade name was used, there might be trademark rights valid, even if they were not explicitly stated.

The proceedings contain complicated technical terms. Wasteconsult does not take any liability for the correctness of the translation. Please check the plausibility of the content you are reading.

Reduce; re-use; recycle – a global necessity

Matthias Kuehle-Weidemeier

Wasteconsult International

Abstract

With regard to the shortage and price increase of resources it is important to break new ground in waste management to support sustainable methods of waste treatment in the future.

The following article gives an overview of the availability and the use of raw materials (fossil fuels, metallic and non-metallic) in some important countries in the world. Also, it is shown how CO_2-emissions can be reduced by recycling and valuable resources can be saved for future generations.

Today's methods of waste treatment (mechanical-biological-treatment or waste incineration) are evaluated concerning their feasibility for sustainable waste management.

Finally recommendations on how to reach a sustainable waste management are presented.

Keywords

waste management, resources, raw materials, waste treatment, MBT, incineration

1 Introduction

The approaching exhaustion of many raw materials and expanding demand for resources due to fast growth of word population and increasing prosperity in many developing countries are a challenge for the world economy and will become a driving factor for enhanced waste treatment / material recovery technology. Quantity and quality of recovered resources from residual waste depend on the kind of waste treatment. Mechanical-biological treatment (MBT) and incineration are the dominant treatment technologies for residual waste and have to prove their feasibility for sustainable waste and resource management.

2 Population growth, consumption of raw materials and available resources

2.1 Population development and consumption of raw materials

The world population will grow from 6.7 billons now (data 2007) to round about 9.1 billon in 2050 (UN, 2009). That corresponds to an average anual growth of 56 millons.

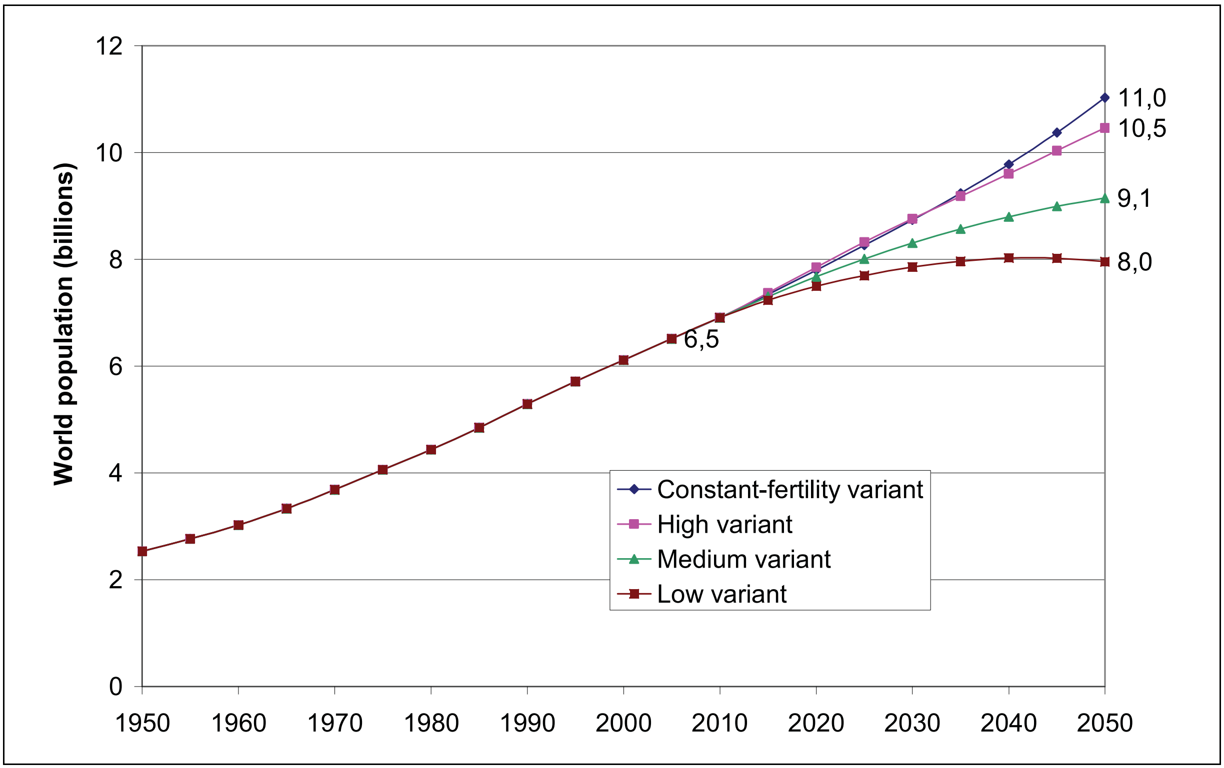


Figure 1: Different scenarios of world population growth (data source: UN, 2009)

The German Foundation for World Population (DSW) reports on their web site a current world population growth of about 81 million people per year. This is nearly as much as the total number of Germany's inhabitants.

Developing and emerging countries show the highest rates of population growth but there are huge differences between the countries. Figure 2 shows the prediction (medium variant) for China and India compared to Germany. Due to their high number of inhabitants and high economic growth, China and India have a high relevance for the topics discussed in this paper.

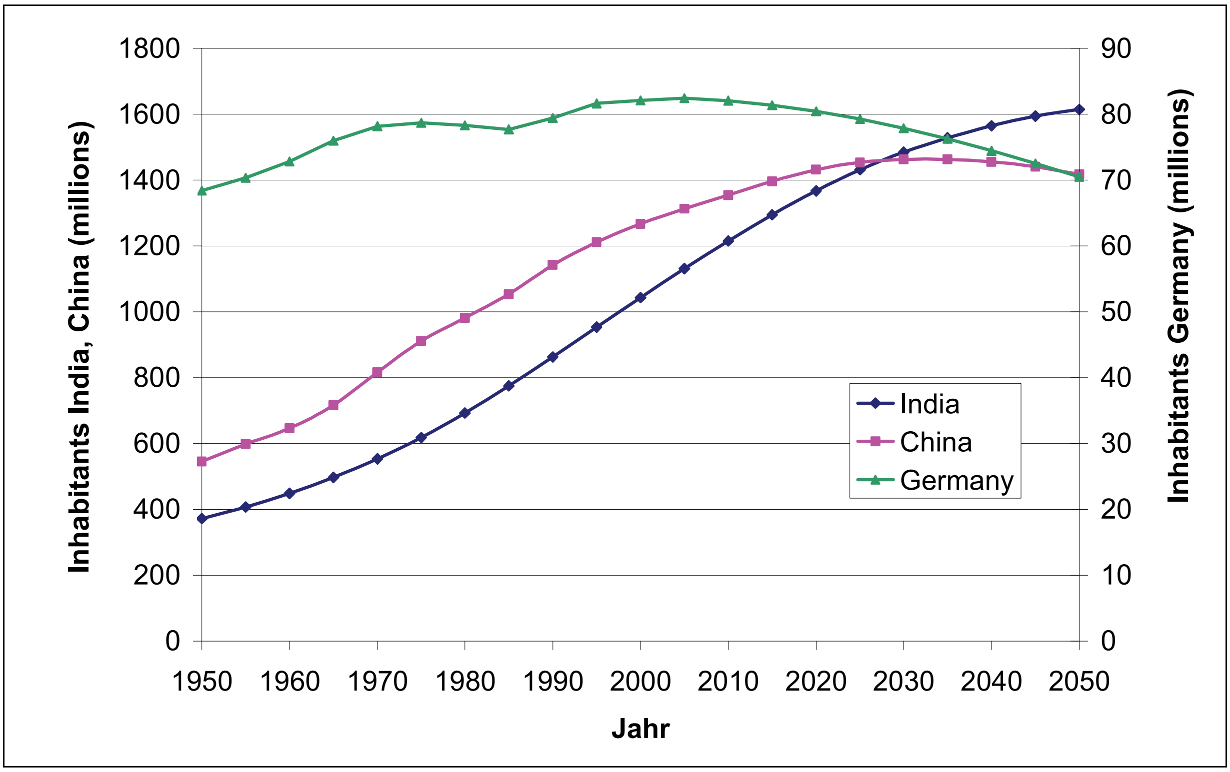


Figure 2: Population development in India, China and Germany, med. variant (data: UN, 2009)

Figure 3 presents the per capita consumption of selected and all resources in different countries. The total includes Biomass. China is already going to approach the average per capita consumption of fossil fuels of the European Union.

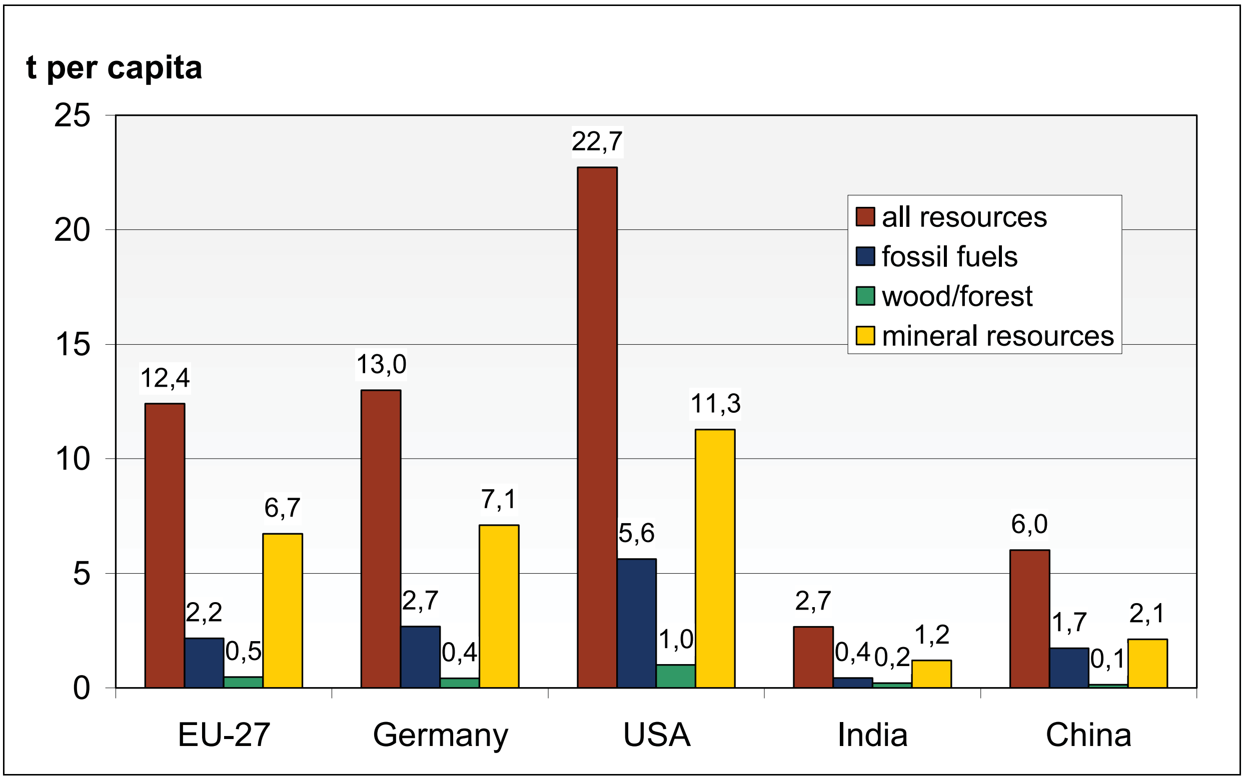


Figure 3: Per capita consumption of resources in different countries (data source: SERI, 2009)

2.2 Important definitions on material reach

For a proper description of the reach of materials (remaining time of availability), some terms need to be defined to avoid misunderstandings due to a different use of these terms in colloquial language. Definitions are according to BARTHEL (1999). These definitions are applied in chapter 2.3 and 2.4 of this article.

Reserve: Those known raw material sources (e.g. ore) that can be economically produced under current market price conditions.

Resource: Proven (natural) material sources were production effort is too high for an economical material production. When the market price increases or cheaper production technologies are developed, resources can become reserves.

Static reach: Time that reserves last (reach of reserves) at a constant production rate

Reach data in chapter 2.3 and 2.4 is based on a constant production rate. An increase of the production rate would shorten the reach.

2.3 Reach of fossil fuels and Uranium

The reach of the non renewable energy resources is important to consider in long term waste management concepts as it will influence the value of refuse derived fuels (RDF) and recovered plastics because oil is the basic raw material for plastics. Oil reserves just last 42 years even under constant production.

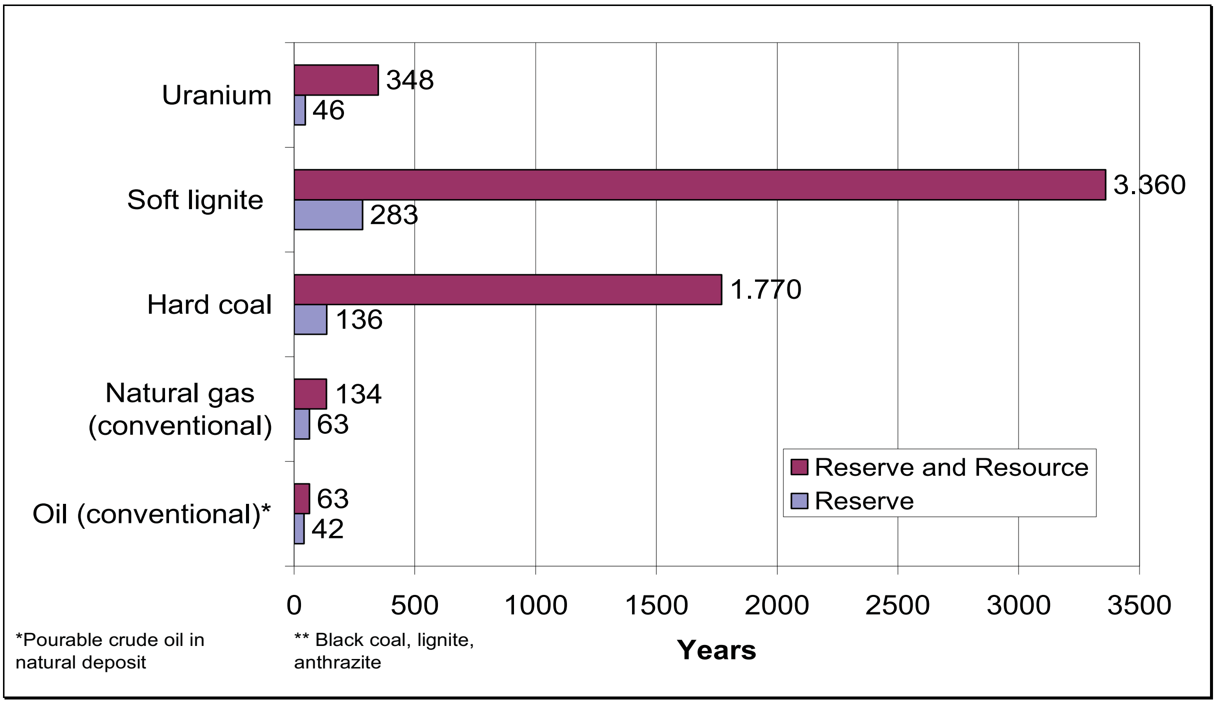


Figure 4: Reach of energy raw materials (data source: BGR 2007)

2.4 Reach of metals and minerals

The reach of metallic and mineral raw materials is not as present as fossil fuels in the public discussion although the reach of many of those irreplaceable materials is even shorter than the reach of oil.

Besides materials that are used for the production of goods, the reach of Phosphate, that is essential for the industrial agriculture and hence for the alimentation of the rapidly growing earth population is only 122 years (BARDT 2008).

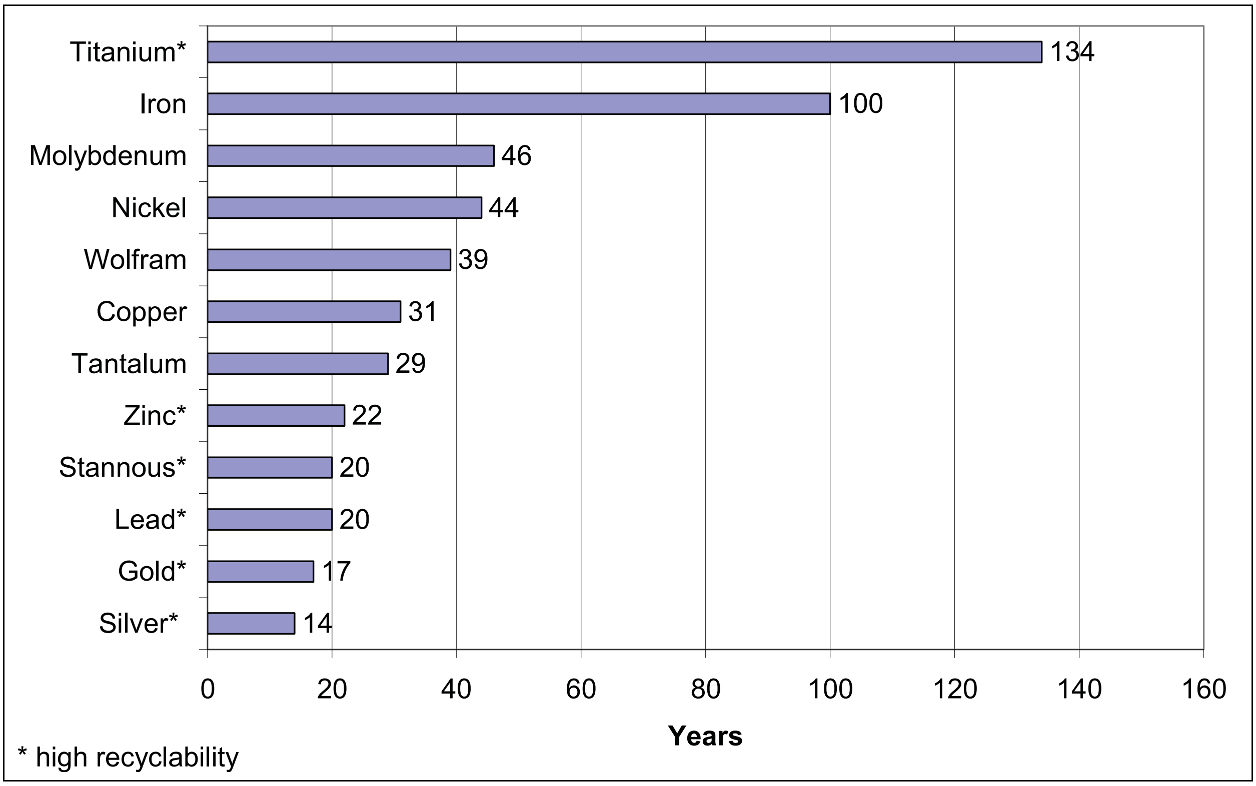


Figure 5: Reach of metallic reserves (DATA SOURCE: BARDT 2008)

The institute of German economy (Institut für Wirtschaft, IW) in Cologne (Köln) published a raw material supply risk list of materials that have a reach of less than 30 years. In spite of their short reach, gold, silver, zinc, stannous and lead do not appear in this list because of their high recyclability. The supply with chrome, molybdenum, columbium (niobium) and metals from the platinum group is classified as very critical in the list. This considers not just the reach but also the situation, that the supply with those metals depends on only 3 countries and 3 companies (BARDT, 2008).

The situation in metal supply is reflected by price development for metallic raw materials that increased by 235% from 2005 to 2008. The price increase of iron ore and steel scrap was even 385% (BARDT 2008). The current massive price drop can be assumed as a temporary event.

2.5 Price development of secondary raw materials

The prices of plastic reclaim (re-granulate) increased significantly in the last years too (50-100% from summer 2003 to summer 2008). With the beginning economical crisis in the second term of 2008 massively declined. This endangers the recycling industry seriously.

The situation of trading prices for used paper is similar:

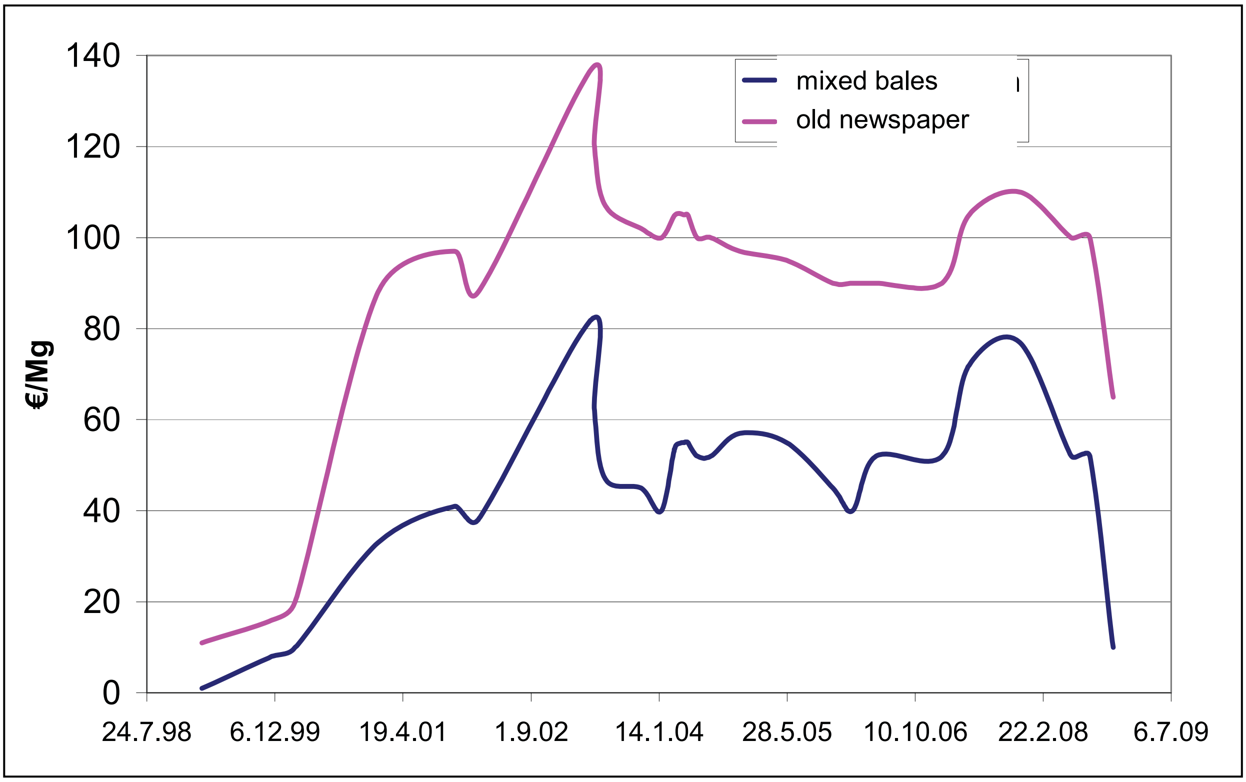


Figure 6: Prices of 2 used paper qualities (data: numerous issues of EUWID Recycling und Entsorgung)

2.6 Reduction of CO_2- emissions by recycling

Recycling is important for climate protection too. By order of INTERSEROH, a German recycling company, Fraunhofer-Institute UMSICHT compared CO_2-emissions caused by the production of primary and secondary materials.

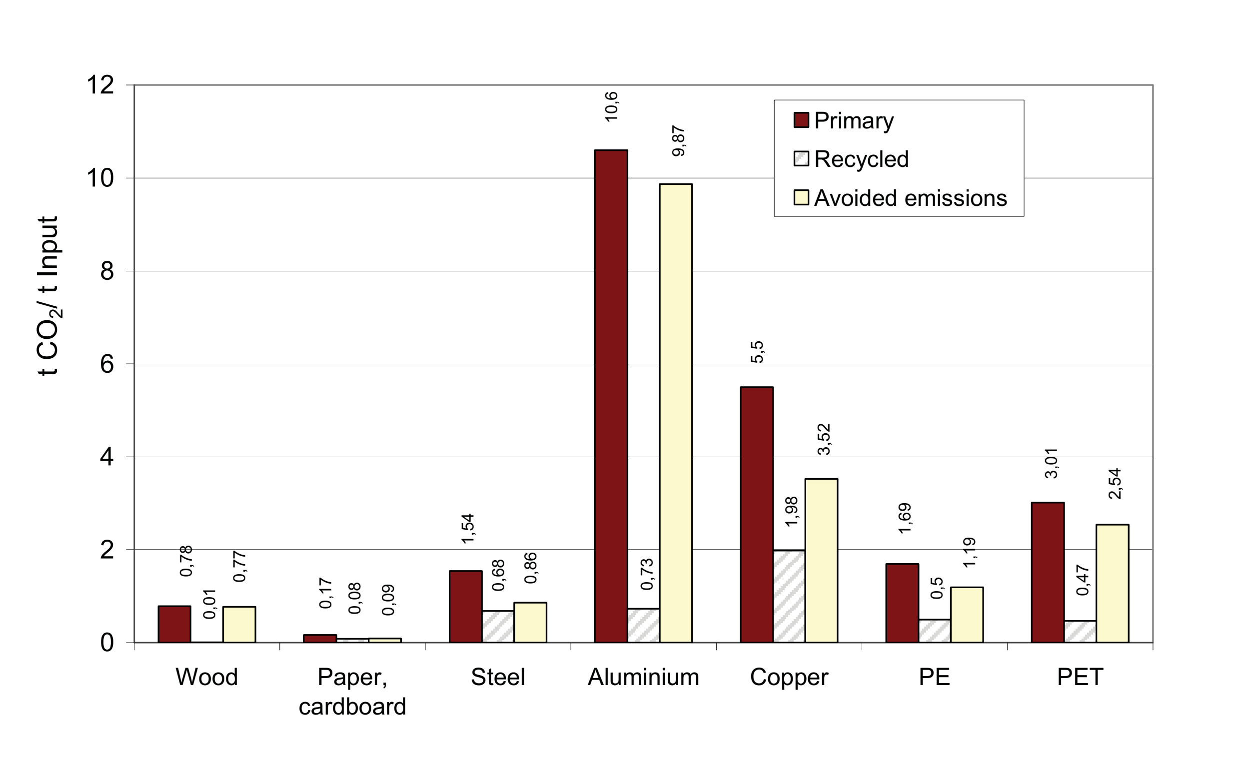


Figure 7: CO_2-emissions by primary and secondary material production and avoided emissions by recycling (data: Interseroh, Umsicht, 2008)

Figure 7 shows that recycling saves an enormous amount of CO2 emissions and thus energy. For example, copper recycling saves 36%, steel recycling 56%, PE recycling 70%, PET recycling 85% and aluminium recycling even 95% compared to primary material production.

The calculated emissions of the recycling process consider collection, transport and the recycling process itself. Considered transport distances to the recycling facilities are based on the true situation. In case of PET this is the transport to south east Asia. It has to be mentioned, that plastics, paper and wood are only feasible for a small number of recycling cycles. Paper fibres can be re-used 5 - 7 times.

3 Feasibility of waste treatment technologies for the requirements of sustainable waste management

3.1 Treatment of residual waste in Germany

Landfilling of non inert waste is not permitted in Germany. Packages and native organic waste are separately collected and recycled. The remaining residual waste is treated by incineration (about 80%) and about 20% mass-% by mechanical-biological treatment (KÜHLE-WEIDEMEIER, 2005).

3.2 Thermal waste treatment (incineration)

3.2.1 „Classic“ incineration of residual waste

Conventional waste incinerators are an approved and very reliable technology for waste treatment. If they are combined with a state of the art exhaust gas treatment system, there is not much reason to be concerned about their toxic emissions.

Depending on it’s quality (leaching test) incinerator bottom ash is used as construction material (mainly for roads) or landfilled. The long term behaviour of incinerator bottom ash is subject of a controversial discussion. The main concern is that possibly a real long term stability (immobilisation of heavy metals) is possibly not given. That is why some opponents call roads constructed with incinerator bottom ash “line landfills”.

A part of the exhaust gas cleaning residues is highly toxic and gets stored in subsurface hazardous waste landfills.

Ferrous metals are removed from incinerator residues by magnetic separation. These metals are heavily oxidised. Non-ferrous metals are inrecoverably lost in the bottom ash.

Another product of incineration is energy. That is why incinerators are sometimes called waste to energy plants (sounds nicer). Municipal solid waste [MSW] (with or without source separated collection) has many components with a low calorific value like water (humidity) soil and much more. Hence, the yield of energy is low. Some incinerators are badly located in areas without demand for the produced heat. In some countries the calorific value of the waste is so low that oil is needed to support the combustion process. In this case, waste to energy converts to energy to waste.

3.2.2 Co-generation plants for refuse derived fuel (RDF)

Co-generation pants that are operated with (pre-treated) high calorific waste (RDF) are real power stations that can be truly called waste to energy plants. They are usually connected to industrial plants that allow using the produced heat (steam) and the electricity too.

3.2.3 Evaluation and future relevance for sustainable waste management

Concerning the conservation of resources, waste incinerators are energy and resource destruction plants. Table 1 reveals how much energy is lost if only the energy represented by the calorific value is recovered.

Table 1: Calorific value and energy equivalent (cal. value + energy effort for production) of some plastic materials (Reimann 1988)

Material	Calorific value [kJ/kg]	Energy equivalent [kJ/kg]
Polyethylen (PE)	43,000	70,000
Polypropylen (PP)	44,000	73,000
Polystrol (PS)	40,000	80,000
PVC hard	18,000	53,000

Only ferrous metals can be recovered from the incineration process. Hence, in a sustainable waste and resource management concept, incineration is feasible only for the treatment of those waste components that can not be recycled or when recycling effort (e.g. energy consumption) exceeds the benefit of recycling. That has been the case with the majority of the MSW in the past. That is why incineration as an expensive but reliable technique is so widespread in Germany.

Innovations and significant cost reductions in waste processing and sensor based waste sorting has changed this situation as well as the approaching shortage of raw materials. After the current economical and raw material price crisis more and more waste components will be picked out by sorting machines. Besides the ecological benefit, this saves cost for expensive treatment like incineration and often even creates a positive income. Some waste management societies have already voluntarily installed sensor based sorting units because they it pays off. Step by step there will be less waste that will be incinerated in Germany, resulting in increasing incinerator over capacities. This development might be delayed by price dumping of incinerator operators.

3.3 Mechanical-biologial treatment (MBT)

3.3.1 Current situation

Figure 9 shows the average mass-balance of the German MBTs. The amount of material recovery in these plants is not very high. From the total of 4.9 million Mg (tons) per year 127,000 Mg ferrous metal and 9,000 Mg non ferrous metals are recycled. The vast majority (2 million Mg) of MBT output goes to energy recovery (incineration) and 1 million Mg are landfilled.

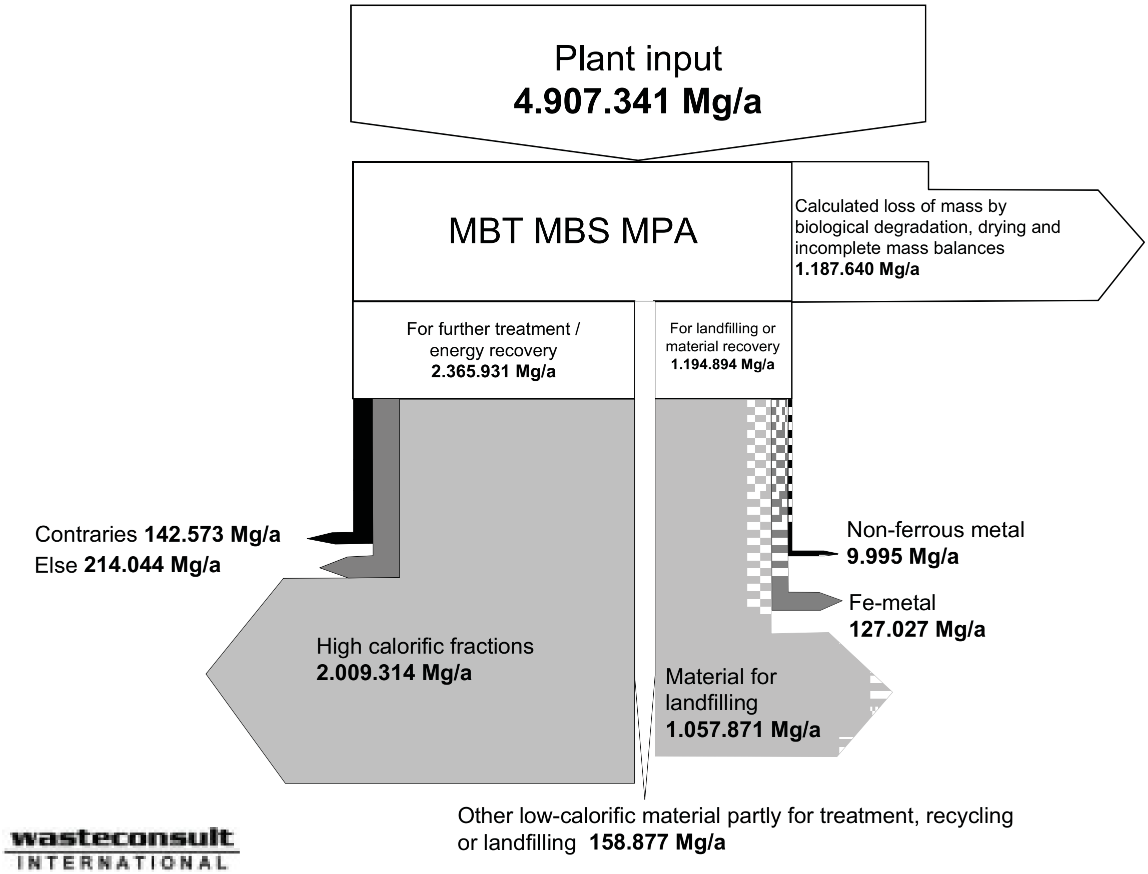


Figure 8: Mass-balance of the German MBTs (Kühle-Weidemeier et al., 2007)

Only anaerobic MBT processes produce energy that covers at least their own energy demand. The other MBT processes just consume energy.

3.3.2 Evaluation

Currently, MBT wastes energy and resources although the material and energy recovery potential is already higher than with conventional incinerators. Even the input of the biological treatment step contains valuable resources that could be picked out (paper, wood, plastics, minerals …), like it is already done in a very few plants.

3.3.3 Enhancement and future potencial of MBT

Big progresses in sensor based sorting makes installation of such units in MBT plants attractive. They are applicable to the coarse fraction as well as to the fine fraction. Best conditions for such applications exist at plants with wet mechanical treatment steps or biological / physical drying. MBT will develop to MRFs with integrated biological treatment.

Figure 9: Various fractions from a biological and wet mechanical treatment step of an MBT

The (former) landfill fraction of MBTs with wet mechanical treatment steps of wet anaerobic treatment does not necessarily has to be landfilled. Figure 9 shows that useable mineral and organic fractions could easily be extracted.

The conception of MBT as a material specific waste treatment technology offers best requirements for a sustainable, resource optimised waste management but it needs to be consequently improved with the focus on material separation and recovery.

4 Resource recovery from landfills

Concepts for material recovery from landfills have come back on the agenda, for example VISVANATHAN ET AL., 2007.

Currently, landfill mining is still to expensive in Europe but with increasing prices of raw materials this might change in a medium range of time. Faulstich (2008) compiled data about recoverable resources in German landfills:

Table 2: Resources in German landfills (Data from Faulstich, 2008)

Deutschland	Deponierte Siedlungsabfälle	Deponierte Massenabfälle	Deponierter Klärschlamm	
Gesamtmenge	960	50	>> 10	Mio. Mg
Fe- + NE-Metalle	32			
Zink		70.000		Mg
Blei		25.000		Mg
Phosphat			1	Mio. Mg

5 Summary and recommendations

Shrinking natural resources, fast growth of the world population and increasing prosperity in emerging and developing countries requires consequently resource optimised acting in general and especially in waste management. A massive increase of the share of materials recovered from waste is necessary. This would enhance material supply and save lots of energy (CO_2-emissions) too. Resource recovery means climate protection.

Enhanced MBTs and sensor based waste sorting plants must become the heart of a sustainable, material specific waste management system. Current MBTs are the first step on this very promising way. MBT will develop to MRF with integrated biological treatment or pure material separation.

Incineration does not meet the requirements of a sustainable, resource optimised waste management concept, because the energy that was spent for the production of the materials that are used as fuels is completely lost in the incineration process. Precious waste components like non-ferrous metals are irrecoverably lost in the incinerator ash. A significant share of the waste that is expensively incinerated at the moment will be cheaper recovered in the future. Hence, there will be less input for incinerators. Incineration will step by step lose it’s importance, although there will always be demand for some incineration capacity because total recovery and recycling is not possible. Countries that are going to design their waste treatment concept should consider this development.