From waste to resource management

Do we still need incineration?

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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 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, 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 between 50 and 100% from 2003 to summer 2008. With the beginning economical crisis in the second term of 2008, prices 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 CO_2 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 irrecoverably 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 8 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.

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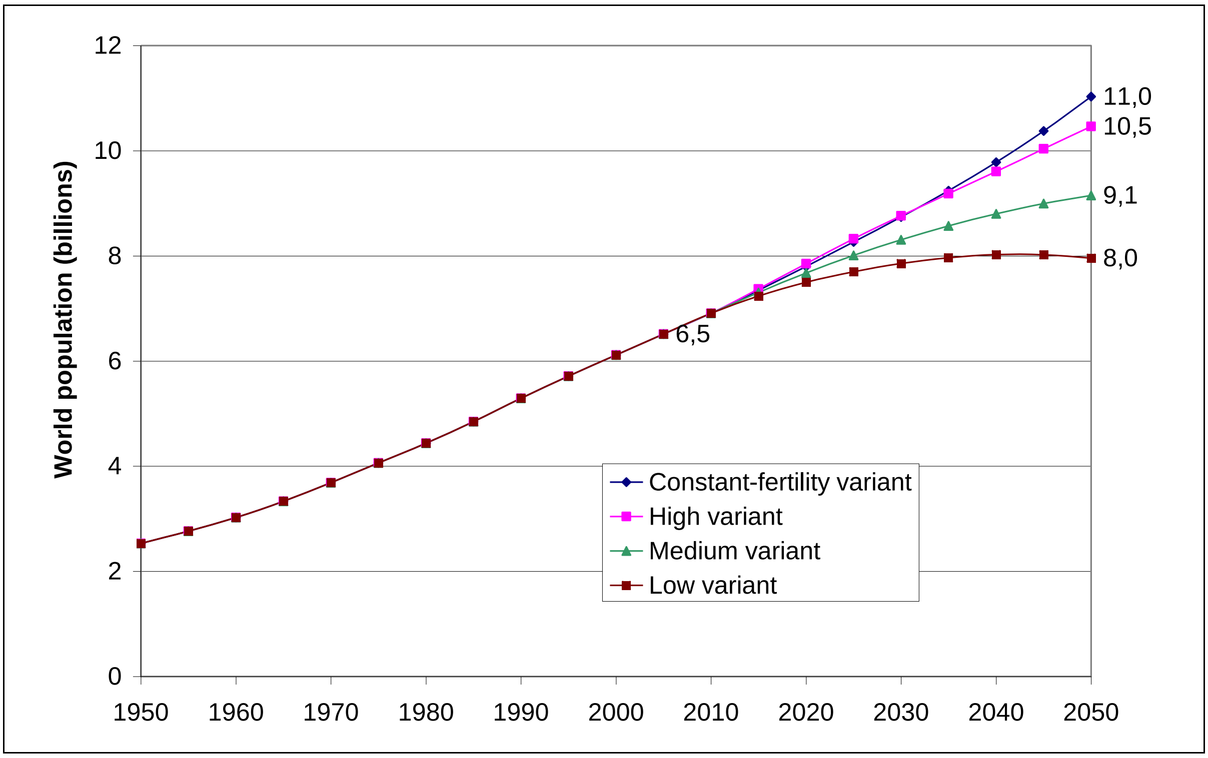
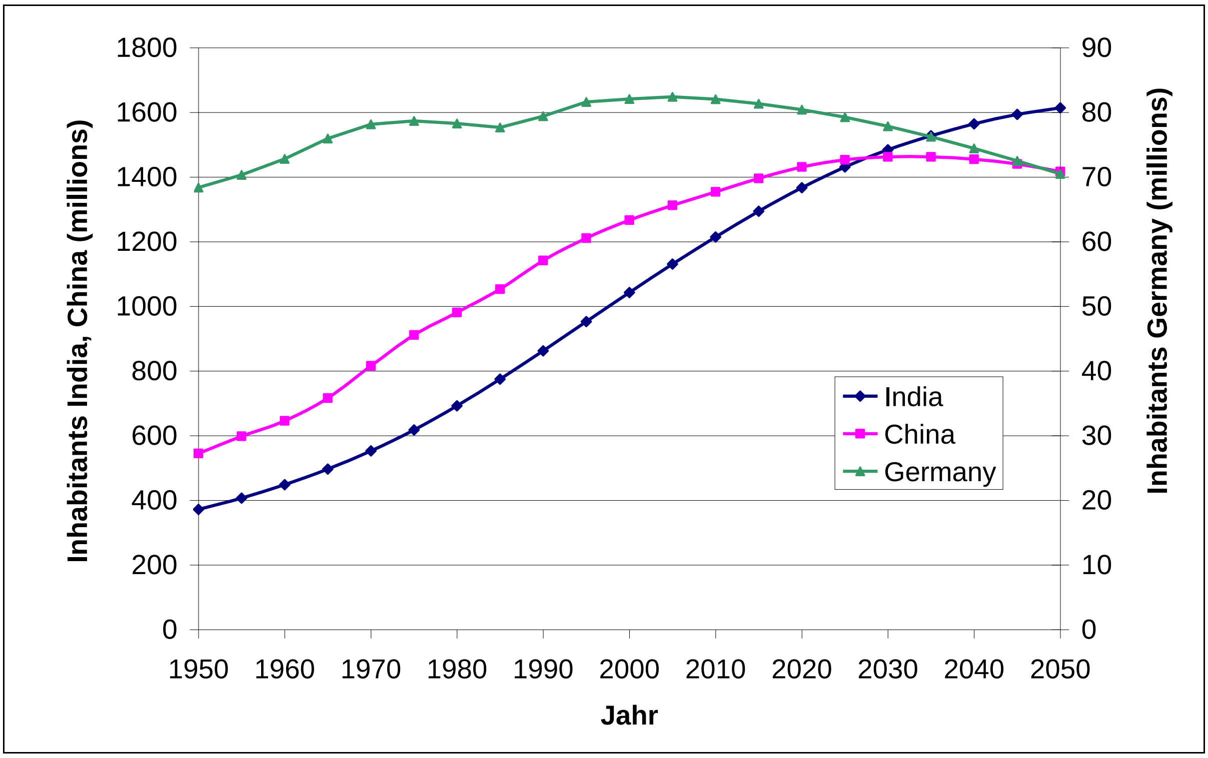


Figure 1: Different scenarios of world population growth (data source: UN, 2009)



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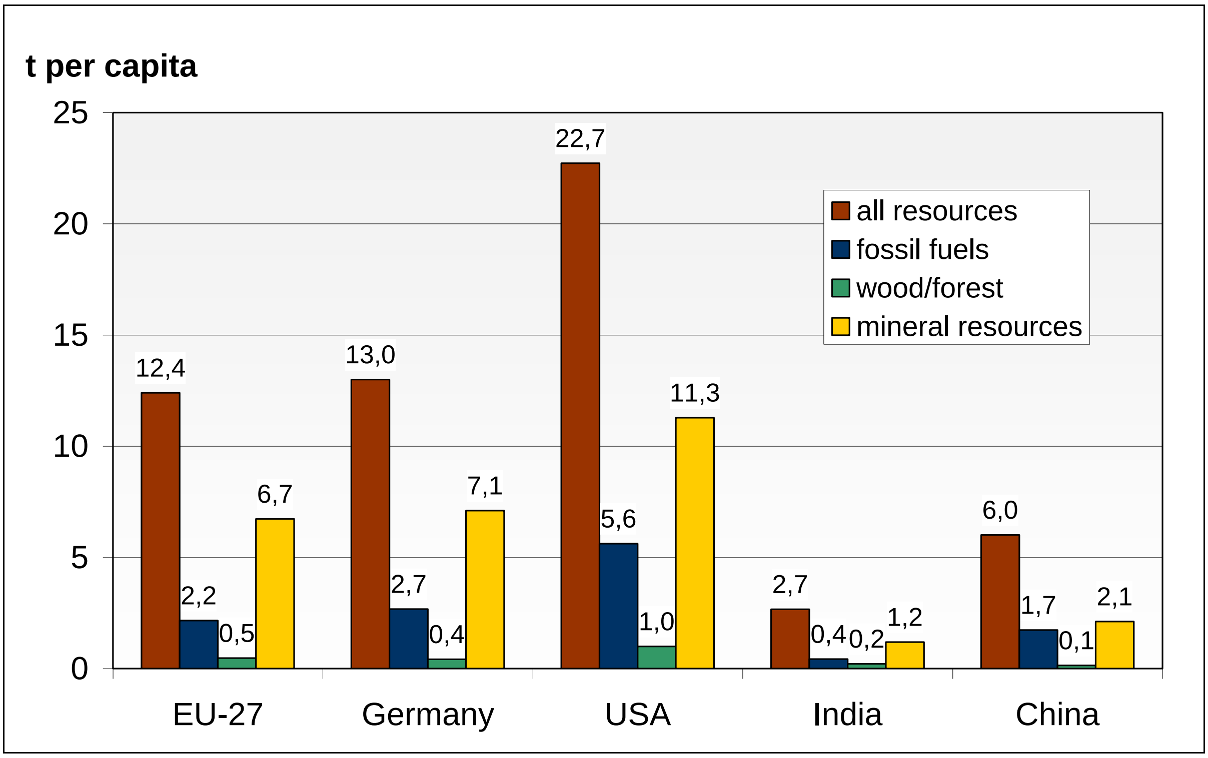


Figure 3: Per capita consumption of resources in different countries (data source: SERI, 2009)

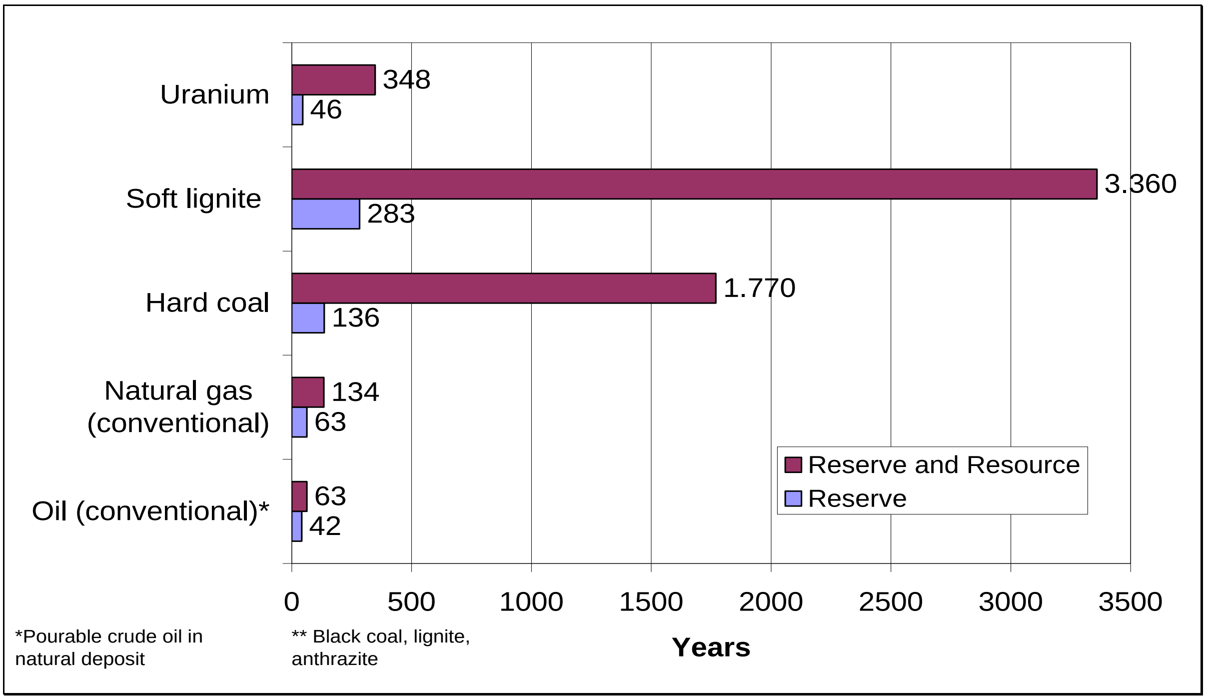


Figure 4: Reach of energy raw materials (data source: BGR 2007)

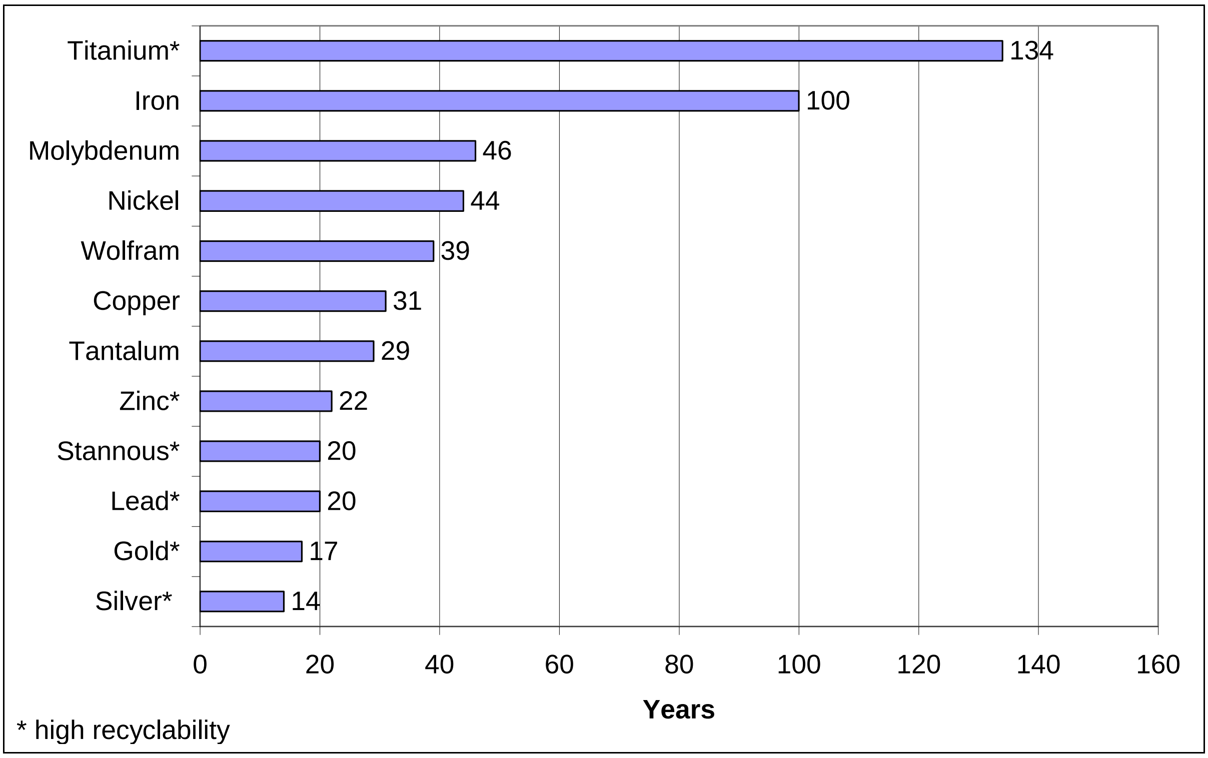
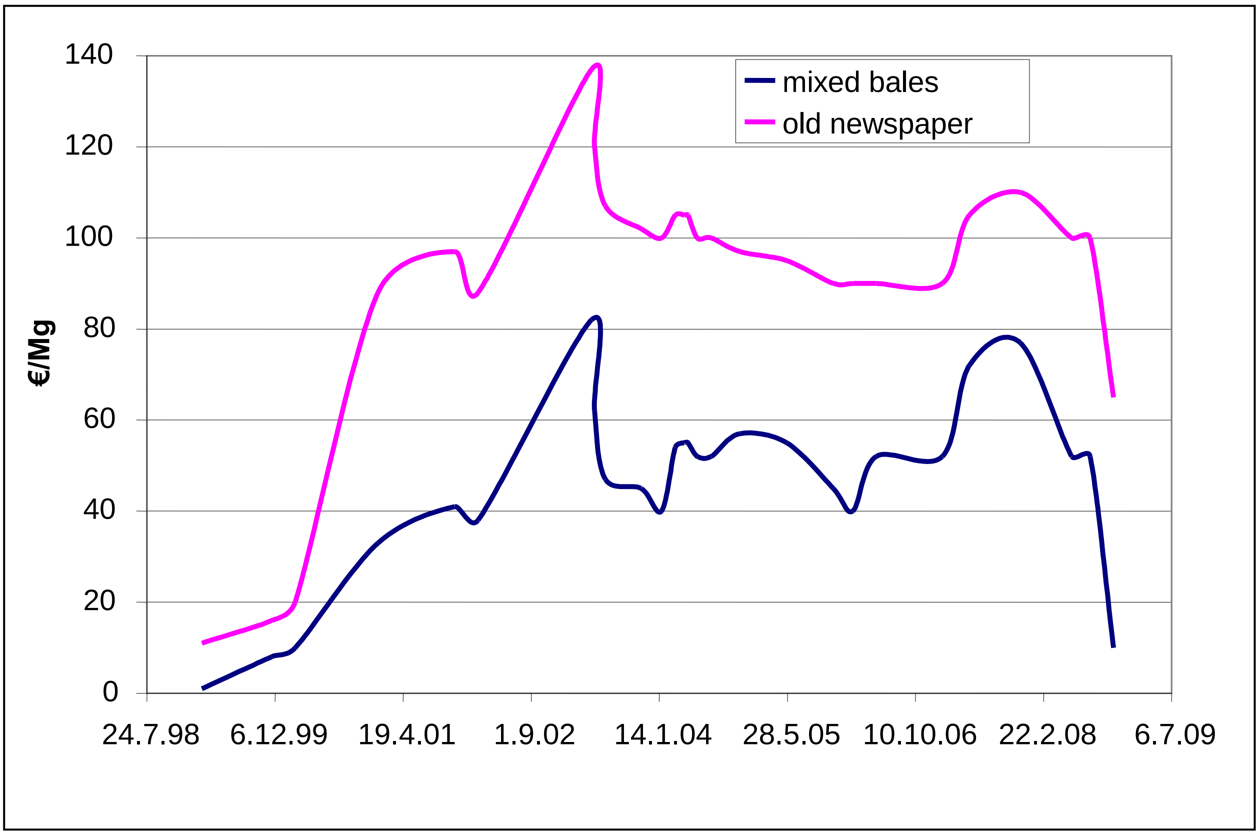


Figure 5: Reach of metallic reserves (DATA SOURCE: BARDT 2008)



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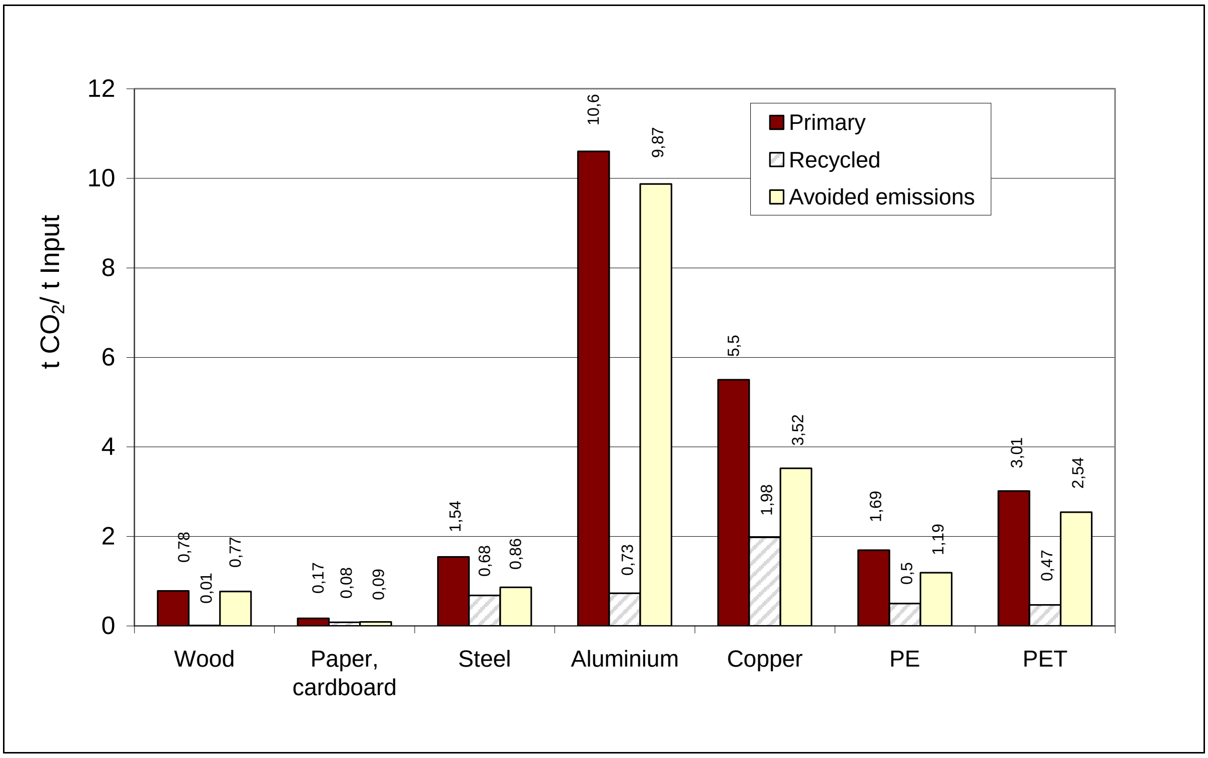

Figure 7: CO_2-emissions by primary and secondary material production and avoided emissions by recycling (data: Interseroh, Umsicht, 2008)

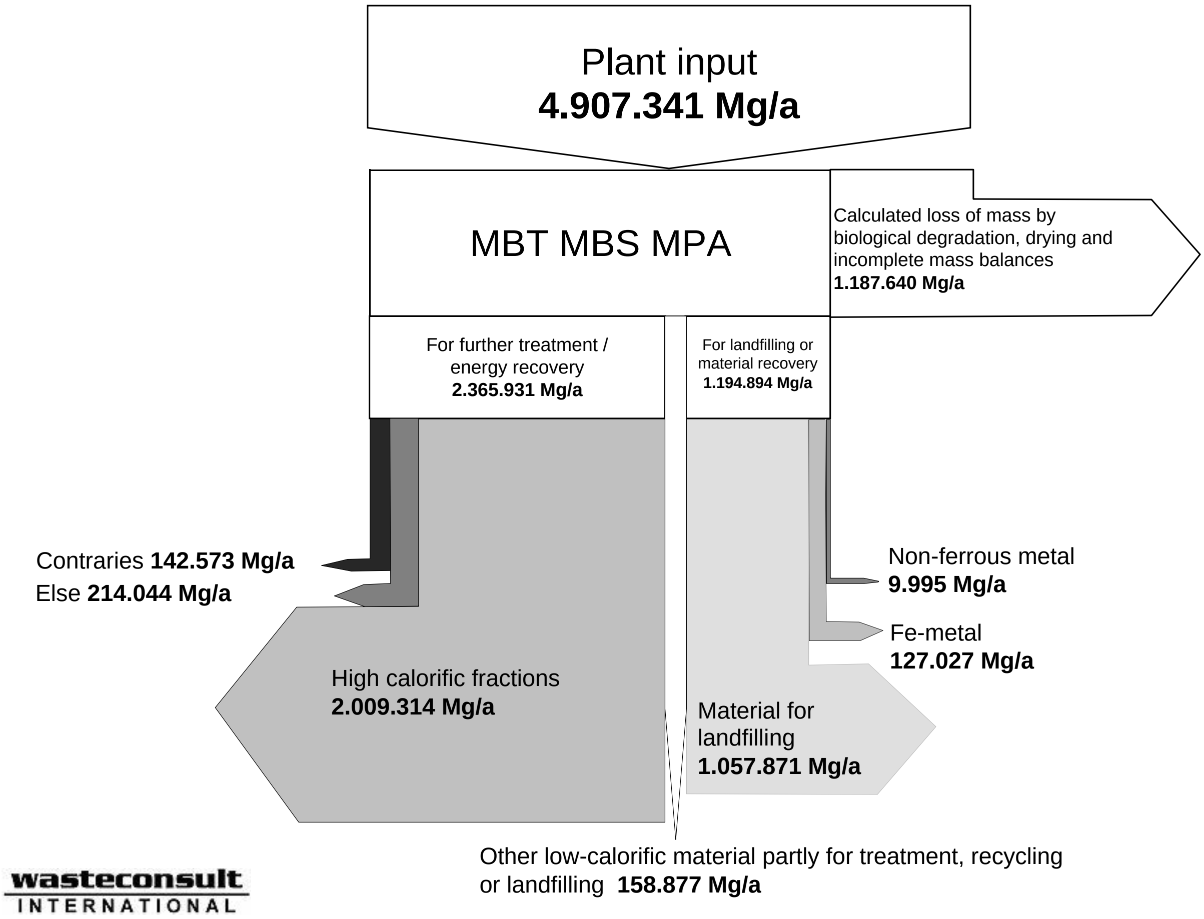

Figure 8: Mass-balance of the German MBTs (Kühle-Weidemeier et al., 2007)

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

OD OTPADA DO UPRAVLJANJA RESURSIMA

TREBAMO LI JOŠ UVIJEK SPALJIVANJE?

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Sažetak

S obzirom na nestašicu i povećanje cijena resursa, bitno je započeti novo razdoblje na području gospodarenje otpadom kako bi poduprli održive metode obrade otpada u budućnosti.

Ovaj rad daje pregled dostupnosti i korištenju sirovih materijala (fosilna goriva, metal ii nemetali) u određenim zemljama. Također, prikazan je način na koji se mogu smanjiti emisije CO_2 kroz reciklažu, a vrijedni resursi se sačuvati za buduće generacije.

Ocjenjene su današnje metode obrade otpada (mehaničko-biološka obrada ili spaljivanje otpada) obzirom na njihovu izvedivost u održivom gospodarenju otpadom.

Prikazane su preporuke kako postići održivo gospodarenje otpadom.

Ključne riječi: gospodarenje otpadom, resursi, obrada otpada, MBO, spaljivanje

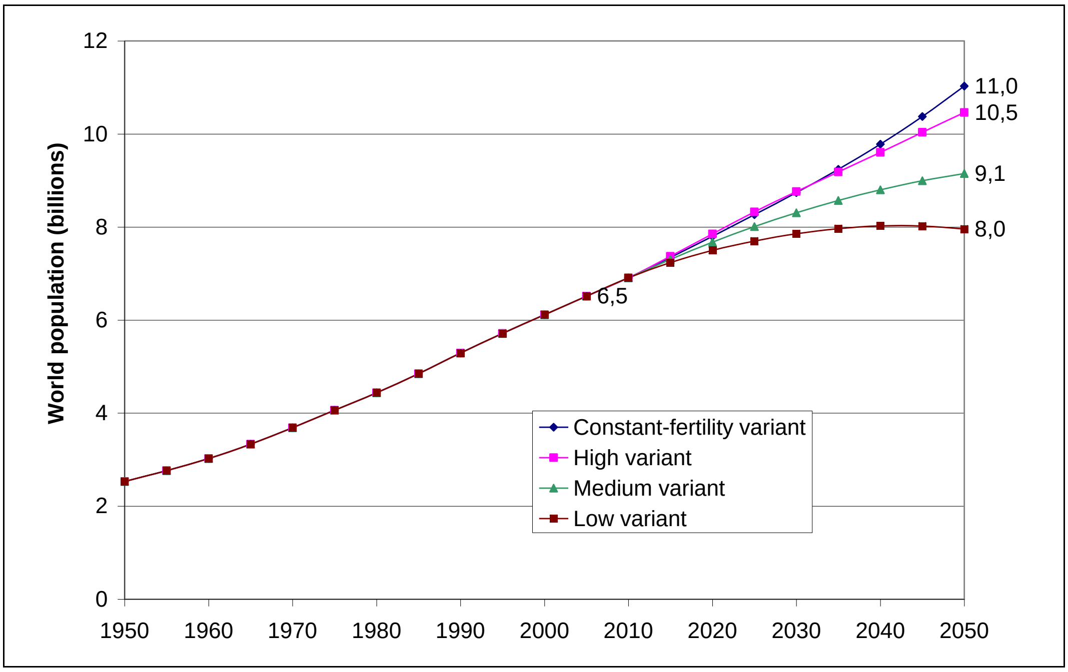
7 Uvod

Nadolazeće iscrpljivanje količina mnogih sirovina i potreba za resursima uslijed brzog rasta svjetske populacije i smanjenja prosperiteta zemalja u razvoju predstavljaju izazov za svjetsku ekonomiju i u budućnosti će postati pogonski faktor za poboljšane tehnologije obrade otpada / materijalne oporabe. Količina i kvaliteta oporabljenih resursa od ostatnog otpada ovisi o vrsti obrade otpada. Mehaničko-biološka obrada (MBO) i spaljivanje su dominantne tehnologije obrade ostatnog otpada i obje tehnologije još trebaju dokazati svoju isplativost za održivo gospodarenje otpadom i resursima.

8 Rast populacije, potrošnja sirovih materijala i dostupni resursi

8.1 Razvoj populacije i potrošnja sirovina

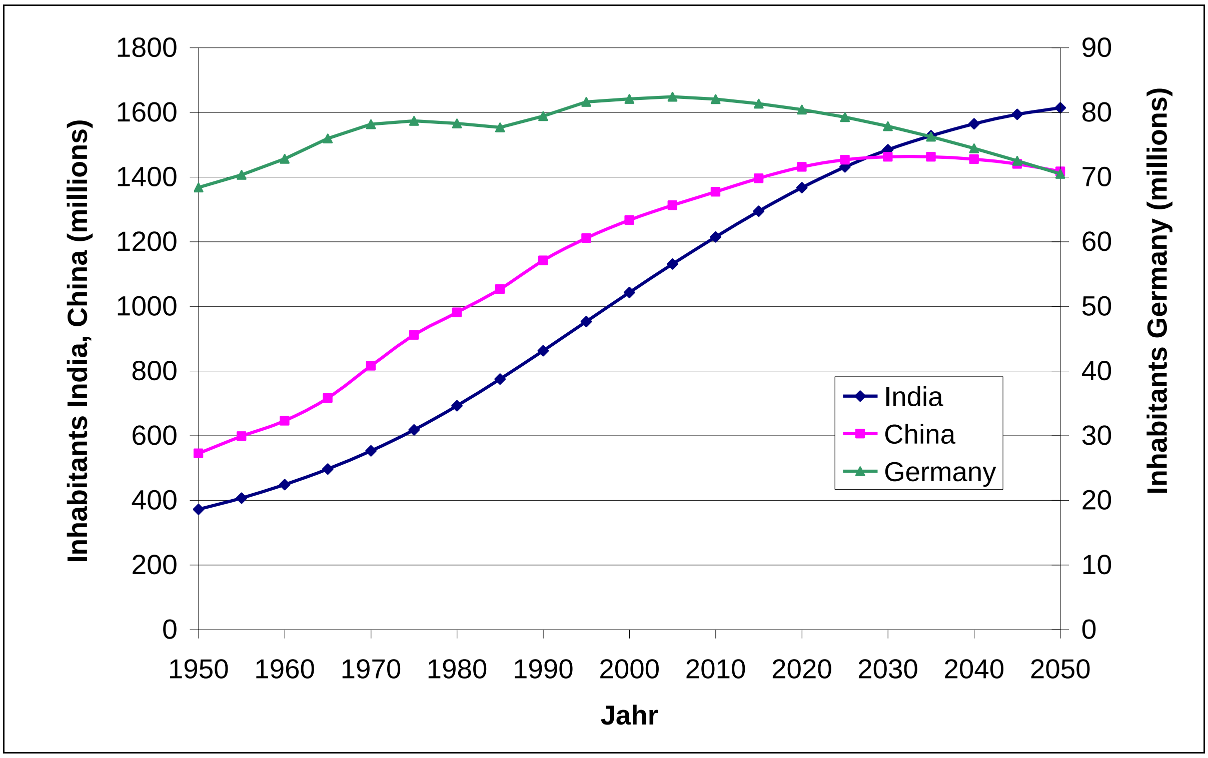
Svjetska populacija će se povećavati od današnjih 6.7 bilijuna (2007. godina) do oko 9.1 bilijuna u 2050. (UN, 2009), što odgovara prosječnom godišnjem rastu od 56 milijuna.



Slika 1: Različiti scenariji rasta svjetske populacije (izvor: UN, 2009)

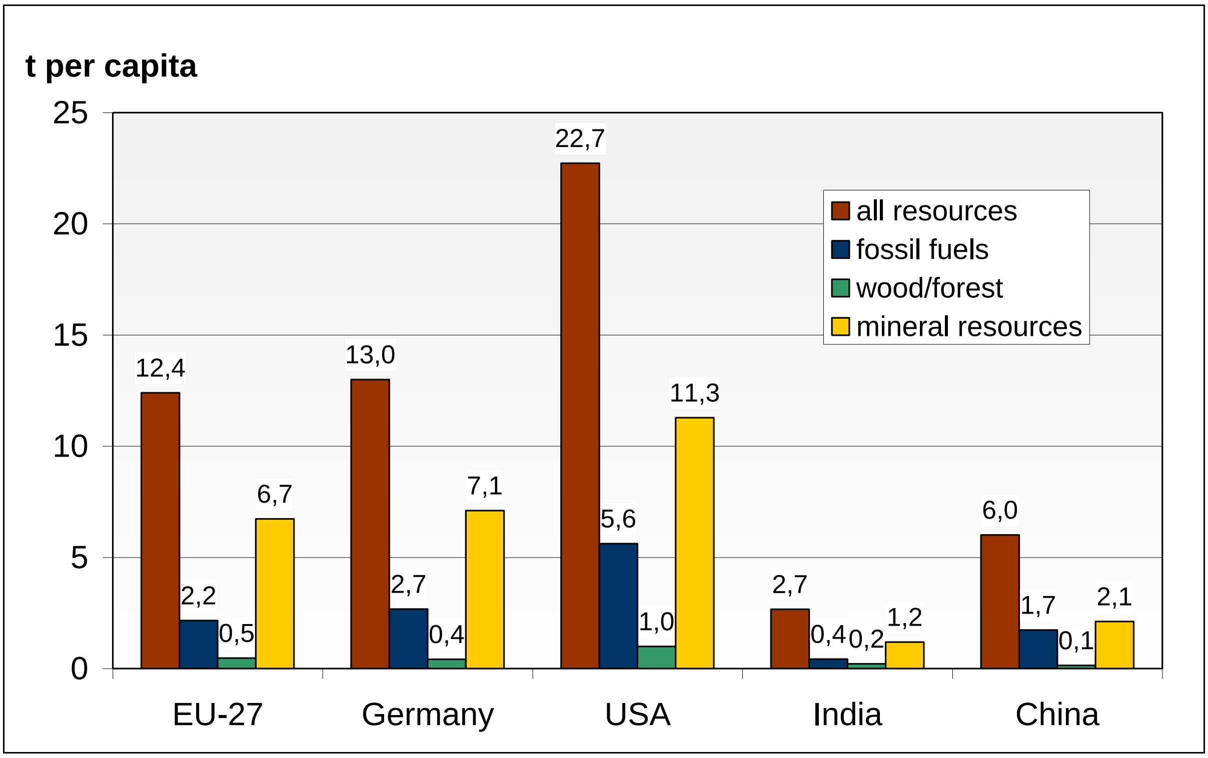
Njemački fond za svjetsku populaciju (DSW) izvještava na svojim web stranicama o trenutnom rastu svjetske populacije od oko 81 milijun ljudi/godišnje što predstavlja gotovo ukupni broj stanovnika Njemačke.

Zemlje u razvoju pokazuju najveću brzinu rasta populacije, no postoje jako velike razlike od zemlje do zemlje. Slika 2 prikazuje predviđanje rasta populacije (srednja varijanta) za Kinu i Indiju u usporedbi s Njemačkom. Zbog velikog broja stanovnika u ovim zemljama i velikog ekonomskog rasta, Kina i Indija imaju veliki utjecaj na teme obuhvaćene ovim radom.



Slika 2: Razvoj populacije u Indiji, Kini i Njemačkoj (izvor: UN, 2009)

Slika 3 predstavlja potrošnju po stanovniku odabranih i cjelokupnih resursa u različitim zemljama. Ukupni iznos uključuje i biomasu. Kina će vrlo skoro doseći prosječnu potrošnju fosilnih goriva po stanovniku Europske unije.



Slika 3: Potrošnja resursa po stanovniku u različitim zemljama (izvor: SERI, 2009)

8.2 Važne definicije o dostupnosti materijala

Kako bi se pravilno opisala dostupnost materijala (preostalo vrijeme dostupnosti), potrebno je definirati pojedine termine kako bi se izbjegle nedoumice zbog korištenja ovih izraza za različite namjene u govornom jeziku. Definicije su izvedene prema BARTHEL (1999). Ove definicije su primijenjene u poglavlju 2.3 i 2.4 ovog rada.

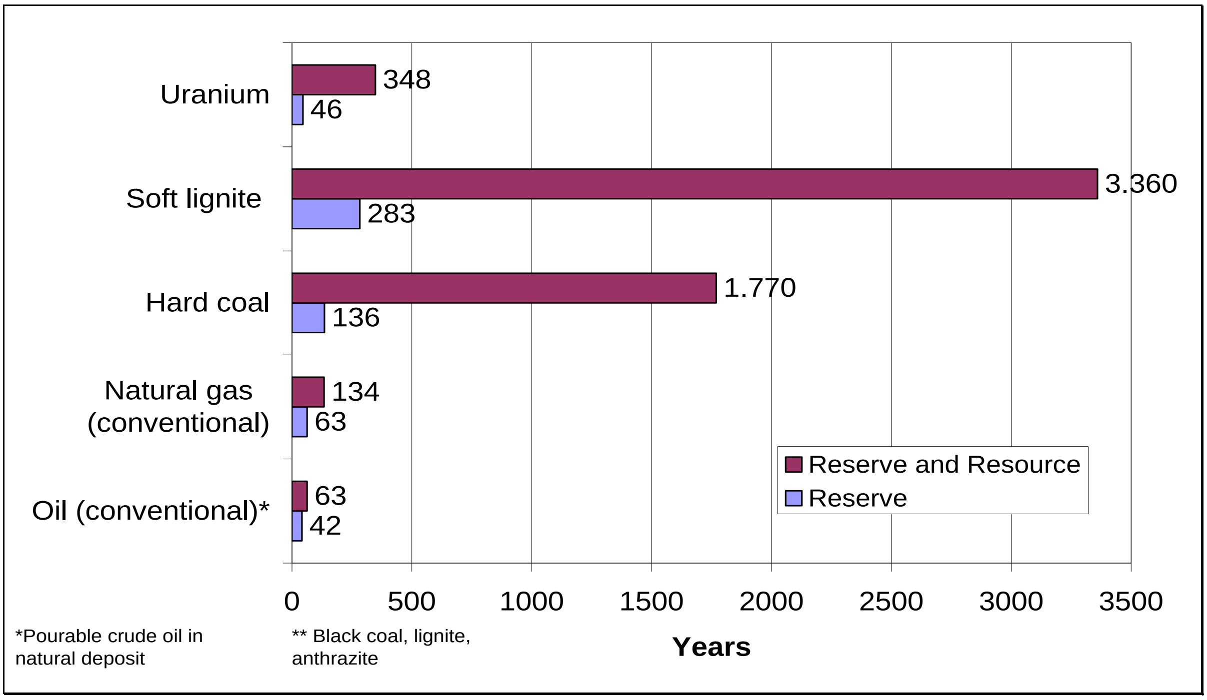
Rezerva: Poznati izvori sirovina (npr. minerali) koji se mogu ekonomski proizvesti po trenutnim tržišnim uvjetima.

Resursi: Dokazani (prirodni) izvori materijala kod kojih je proizvodni napor prevelik za ekonomsku materijalnu proizvodnju. Kad tržišna cijena padne ili se razviju jeftinije tehnologije, resursi mogu postati rezerve.

Statička dostupnost: Posljednje rezervirano vrijeme (dostupnost rezervi) pri konstantnoj brzini proizvodnje

Dostupnost fosilnih goriva i urana

Dostupnost neobnovljivih energetskih resursa je karika koju se mora uzeti u obzir u dugoročnim konceptima gospodarenja otpadom jer će ona utjecati na vrijednost goriva iz obnovljivih izvora (RDF) i oporabljene plastike obzirom je ulje temeljna sirovina za plastiku. Ulje, posljednjih 42 godine bilježi proizvodnju ispod konstante.

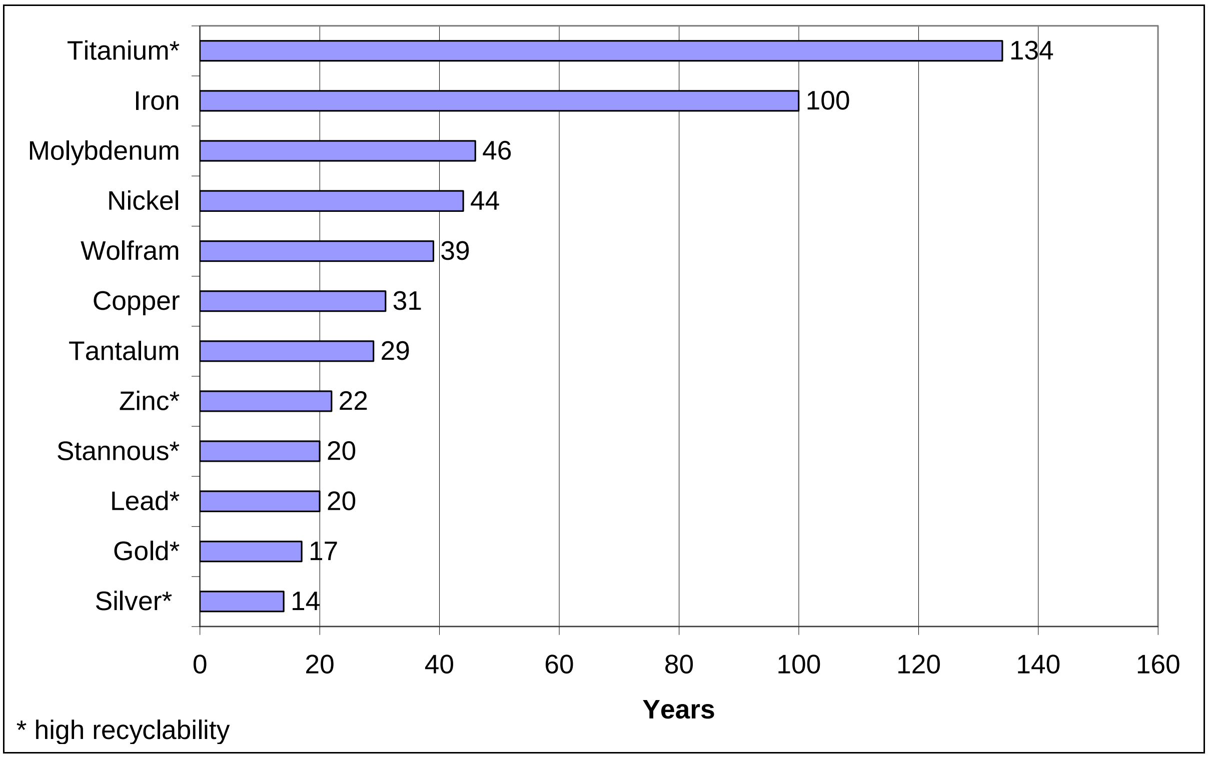


Slika 4: Dostupnost energetskih materijala (izvor: BGR 2007)

8.3 Dostupnost metala i minerala

Teme o dostupnosti metalnih i mineralnih sirovina nisu toliko prisutne u javnim diskusijama kao što su to fosilna goriva, iako je dostupnost ovih nezamjenjivih materijala čak i manja od dostupnosti ulja.

Osim toga, materijali koji se koriste kod proizvodnje dobara, dostupnost fosfata, koji su esencijalni za industrijsku agrikulturu i stoga za prehranjivanje brzorastuće svjetske populacije je samo 122 godina (BARDT 2008).



Slika 5: Dostupnost metalnih rezervi (izvor: BARDT 2008)

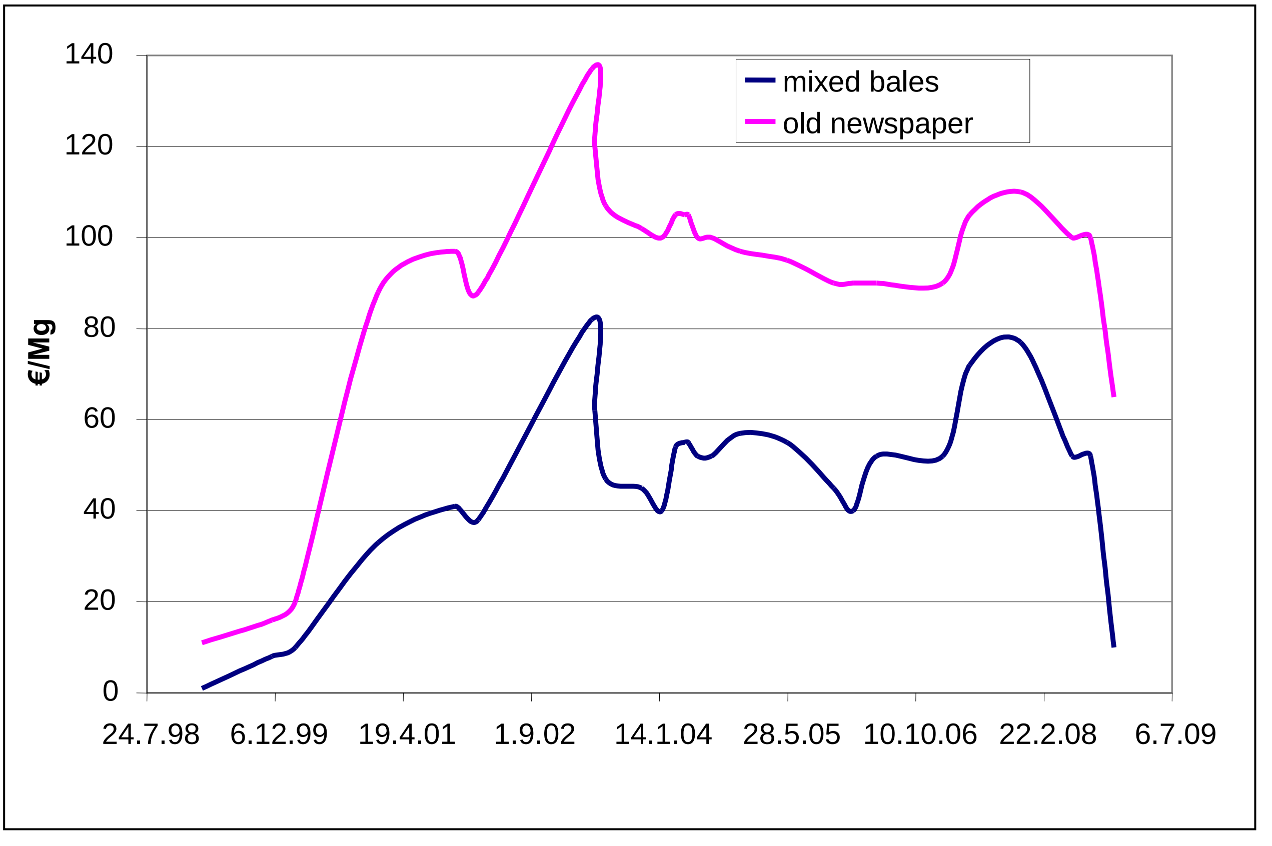
Institut za njemačku ekonomiju (Institut für Wirtschaft, IW) u Cologne (Köln) je izdao listu rizičnih sirovina koji imaju dostupnost manje od 30 godina. Unatoč njihovoj kratkoj dostupnosti, zlato, srebro, cink, kositar i olovo se ne pojavljuju na ovoj listi zbog njihove velike recikličnosti. Opskrba kromom, molibdenom, niobijem i platinastim metalima je klasificirana kao vrlo kritična na listi. Ovo se ne odnosi samo na dostupnost, već i na situaciju da opskrba ovim metalima ovisi o samo 3 zemlje i 3 tvrtke (BARDT, 2008).

Situacija s opskrbom metalima se reflektira razvoj cijene za metalne sirovine koja je smanjena za 235% od 2005 do 2008. Pad cijene željeznih kovina i otpadnog čelika iznosio je čak 385% (BARDT 2008). Sadašnji masivni pad cijene može se smatrati trenutnim događajem.

8.4 Razvoj cijena sekundarnih sirovina

Cijena plastičnih ostataka (re-granulata) pala je između 50 i 100% od 2003 do ljeta 2008. S početkom ekonomske krize u drugom dijelu 2008. godine, cijene su masivno pale što ozbiljno šteti reciklažnoj industriji.

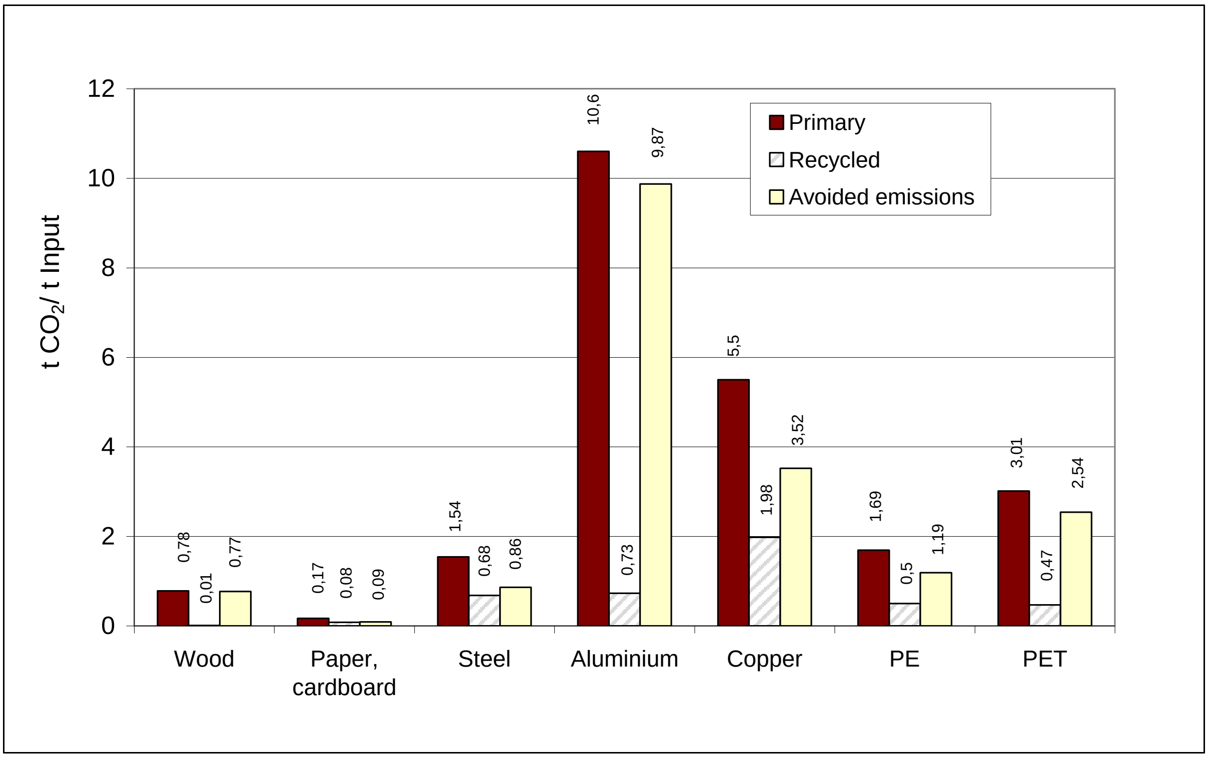
Situacija s tržišnim cijenama korištenog papira je slična:



Slika 6:Cijene korištenog papira dviju kvaliteta (izvor: EUWID Recycling und Entsorgung)

8.5 Smanjenje emisija CO_2 reciklažom

Reciklaža je također vrlo bitna za zaštitu klime. Njemačka tvrtka koja se bavi reciklažom, Fraunhofer-Institute UMSICHT usporedila je CO_2 emisije uzrokovane proizvodnjom primarnih i sekundarnih materijala.



Slika 7: CO_2 emisije nastale uslijed proizvodnje primarnih i sekundarnih materijala i izbjegnute reciklažom (izvor: Interseroh, Umsicht, 2008)

Slika 7 prikazuje da se reciklažom štede enormne količine CO_2 emisija i samim time energije. Na primjer, reciklažom bakra izbjegava se 36% emisija CO_2, reciklažom čelika 56%, reciklažom PE 70%, reciklažom PET 85% i reciklažom aluminija čak 95% u usporedbi s proizvodnjom primarnih materijala.

Izračunate emisije iz procesa reciklaže u obzir uzimaju sakupljanje, transport i sam proces reciklaže. Udaljenosti do postrojenja za reciklažu nisu pretpostavljene već stvarne. U slučaju PET-a, transport se odvija do jugoistočne Azije. Treba napomenuti da se plastika, papir i drvo isplati reciklirati kod malog broja ciklusa reciklaže. Vlakna papira mogu se ponovno koristiti 5-7 puta.

9 Isplativost tehnologija obrade otpada prema zahtjevima održivog gospodarenja otpadom

9.1 Obrada ostatnog otpada u Njemačkoj

Odlaganje ne-inertnog otpada nije dozvoljeno u Njemačkoj. Ambalaža i organski otpad se odvojeno sakupljaju i recikliraju. Ostatni otpad se obrađuje u spalionicama (oko 80%) i oko $20\%_{mas}$ mehaničko-biološkom obradom (KÜHLE-WEIDEMEIER, 2005).

9.2 Termička obrada otpada (spalionica)

9.2.1 „Klasična“ spalionica ostatnog otpada

Konvencionalne spalionice otpada predstavljaju dokazane i vrlo pouzdane tehnologije obrade otpada. Ukoliko se kombiniraju s najnovijim sustavom obrade ispušnih plinova, nema razloga za zabrinutost zbog toksičnih emisija.

Ovisno o kvaliteti šljake (analiza eluata), ona se može koristiti kao građevinski materijal (većinom za ceste) ili odlagati. Dugoročno ponašanje šljake iz spalionice je predmet kontroverznih diskusija. Glavna zabrinutost je da dugoročna stabilnost (imobilizacija teških metala) nije moguća. Upravo zbog toga pojedini oponenti nazivaju ceste izgrađene od šljake iz spalionice “cestovna odlagališta”.

Dio ostataka od čišćenja ispušnih plinova je izuzetno toksičan i odlaže se u podzemna odlagališta opasnog otpada.

Željezni metali se izdvajaju iz spalionice magnetom. Ovi metali su visoko oksidirajući. Neželjezni metali su nepovratno izgubljeni u šljaki.

Drugi proizvod spalionice je energija zbog koje se spalionice ponekad nazivaju postrojenja otpad-u-energiju (waste to energy). Komunalni otpad (s ili bez odvojenog sakupljanja na izvoru) sadrži mnogo komponenti male kalorijske vrijednosti poput vode (vlage), zemlje i mnogih drugih. Stoga je povrat energije nizak. Neke spalionice su loše smještene u područja na kojima ne postoji potreba za proizvedenom toplinom. U nekim zemljama kalorijska vrijednost otpada je tako niska da je potrebno dodati ulja koja podržavaju proces sagorijevanja. U ovim slučajevima, otpad-u-energiju pretvara se u energija-u-otpad.

9.2.2 Kogeneracija postrojenja za goriva iz o bnovljivih izvora (RDF)

Postrojenja za kogeneraciju koja rade s (pred-obrađenim) otpadom visoke kalorijske vrijednosti (RDF) su prave električne centrale koje se u punom smislu riječi mogu nazivati waste to energy postrojenjima. One su obično spojene na industrijska postrojenja te imaju dozvolu za korištenje proizvedne topline (pare) i električne energije.

9.2.3 Procjena i buduća primjerenost za održivo gospodarenje otpadom

Uzimajući u obzir očuvanje resursa, spalionice otpada predstavljaju postrojenja za uništenje energije i resursa. Tablica 1 otkriva koliko se energije izgubi ako se oporabljuje samo energija iz kalorijske vrijednosti.

Tablica 1: Kalorijska vrijednost i energijski ekvivalent (cal. vrijednost + energija potrebna za proizvodnju) pojedinih plastičnih materijala (Reimann 1988)

Materijal	**Kalorijska vrijednost [kJ/kg]**	**Energijski ekvivalent [kJ/kg]**
Polietilen (PE)	43,000	70,000
Polipropilen (PP)	44,000	73,000

Polistirol (PS)	40,000	80,000
PVC tvrdi	18,000	53,000

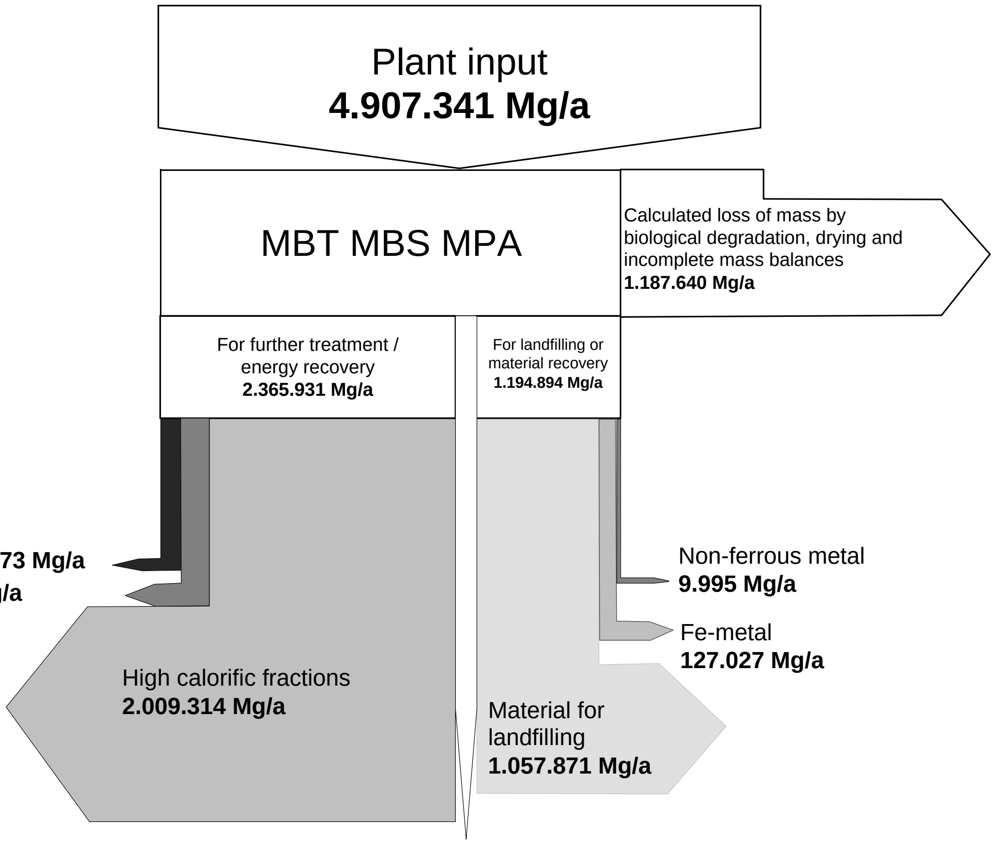
Samo se željezni metali mogu oporabiti iz procesa spaljivanja. Međutim, u konceptu održivog gospodarenja otpadom i resursima, spalionica je isplativa samo za obradu onih komponenti otpada koje se ne mogu reciklirati ili kada potrošnja za potrebe reciklaže (npr. Potrošnja energije) premašuje dobrobiti reciklaže. To je bio slučaj s većinom komunalnog otpada u prošlosti. Upravo zbog toga je spaljivanje, kao skupa, ali pouzdana tehnologija rasprostranjena u Njemačkoj.

Inovacije i značajna smanjenja troškova u procesuiranju otpada i sortiranje otpada pomoću senzora je promijenilo situaciju kao i nadolazeća oskudica sirovina. Nakon trenutne krize kako ekonomske, tako na tržištu sirovina, sve više komponenti otpada će se izdvajati strojevima za sortiranje. Osim ekološke dobobiti, na ovaj način će se smanjiti troškovi skupe obrade poput spaljivanja, a ponekad je moguće ostvariti i pozitivan prihod. Pojedina društva za gospodarenje otpadom su već dobrovoljno ugradila jedinice za sortiranje sa senzorima jer im se to isplati. U Njemačkoj će korak po korak biti sve manje otpada koji će se spaljivati. Ovakav scenarij može se odgoditi smanjenjem cijena od strane operatera spalionice.

9.3 Mehaničko-biološka obrada (MBO)

9.3.1 Trenutna situacija

Slika 8 pokazuje prosječnu bilancu mase njemačkih MBO-a. Materijalna oporaba u ovim postrojenjima nije naročito visoka. Od ukupno 4,9 milijuna Mg (tona) godišnje, 127.000 Mg željeznih i 9.000 Mg ne-željeznih metala se reciklira. Velika većina (2 milijuna Mg) izlaza iz MBO-a otpada na energetsku oporabu (spaljivanje), a 1 milijun Mg se odlaže. .



Slika 8: Bilanca mase njemačkih MBO-a (Kühle-Weidemeier et al., 2007)

Samo anaerobni MBO procesi proizvode energiju koja pokriva barem onoliko energije koliko sam proces zahtijeva. Ostali MBO procesi samo troše energiju.

9.3.2 Procjena

Trenutno, MBO troši energiju i resurse iako je potencijal MBO-a za materijalnu i energetsku oporabu viši nego kod konvencionalnih spalionica. Čak i ulazni materijal u biološki stupanj obrade sadrži vrijedne resurse koji se mogu izdvojiti (papir, drvo, plastika, minerali…), što se i primjenjuje na nekoliko postrojenja.

9.3.3 Poboljšanje i budući potencijal MBO-a

Veliki napredak na području sortiranja temeljenog na senzorima čini ugradnju ovih jedinica u MBO postrojenja zanimljivom. One se mogu primijeniti na krupnu frakciju kao i na fine frakcije. Najbolji uvjeti rada za ovakve jedinice su u postrojenjima sa stupnjem vlažne mehaničke obrade ili biološko/fizičkog sušenja.

Slika 9: Različite frakcije iz biološkog i vlažnog mehaničkog stupnja obrade u MBO-u

Frakcija MBO-a koja sadrži stupanj vlažne mehaničke obrade koja se prije odlagala, ne treba se više odlagati. Slika 9 pokazuje da se iskoristive mineralne i organske frakcije mogu lagano izlučiti.

Koncept MBO-a kao tehnologije za materijalnu obradu ispunjava uvjete za održivo, optimizirano gospodarenje otpadom, i taj koncept se stalno poboljšava s posebnim naglaskom na materijalno odvajanje i oporabu.

10 Oporaba resursa iz odlagališta

Koncepti oporabe materijala iz odlagališta ponovno su stavljeni na dnevni red, na primjer VISVANATHAN ET AL., 2007.

Trenutno je iskapanje odlagališta preskupo za Europu, ali porastom cijena sirovina, ova činjenica bi se mogla promijeniti u relativno kratkom vremenu. Faulstich (2008) je usporedio podatke o resursima koji se mogu oporabiti na Njemačkim odlagalištima:

Tablica 2: Resoursi u Njemačkim odlagalištima (Faulstich, 2008)

Njemačka	Deponierte Siedlungsabfälle	Deponierte Massenabfälle	Deponierter Klärschlamm	
Gesamtmenge	960	50	>> 10	Mil. Mg
Fe- + NE-Metali	32			
Cink		70.000		Mg
Blei		25.000		Mg
PhosFosfatphat			1	Mil. Mg

11 Zaključak i preporuke

Smanjenje prirodnih resursa, brzi rast svjetske populacije i povećanje prosperiteta u razvijenim zemljama i zemljama u razvoju zahtjeva optimizirano postupanje s resursima općenito, a posebno na području gospodarenja otpadom. Nužno je potrebno masivno povećanje udjela materijala oporabljenih iz odlagališta. Time bi se poboljšala opskrba materijalom i spriječili veliki gubici energije (CO_2-emisije) također. Oporaba resursa doslovno znači zaštita klime.

Poboljšani MBO-i i postrojenja za sortiranje koja se temelje na senzorima će se razviti u MRF s integriranom biološkom obradom ili čistim materijalnim odvajanjem.

Spalionice ne ispunjavaju uvjete održivog, optimiziranog, koncepta gospodarenja otpadom, jer energija potrošena za proizvodnju materijala koji se koriste kao goriva, se u potpunosti potroši u procesu spaljivanja. Dragocjene komponente otpada poput ne-željeznih metala se nepovratno izgube u pepelu iz spalionice. Značajan udjel otpada koji se trenutno skupo spaljuje će se u budućnosti jeftinije oporabljivati. Međutim, isto će značiti manje ulaznog materijala za spalionice. Spaljivanje će korak po korak izgubiti na važnosti, iako će uvijek postojati potreba za određenim kapacitetima za spaljivanje jer potpuna oporaba i reciklaža nije moguća. Zemlje koje izrađuju koncepte za gospodarenje otpadom svakako u obzir moraju uzeti sve navedeno-

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