Odpady alebo suroviny ?

Ing. Marek Hrabčák

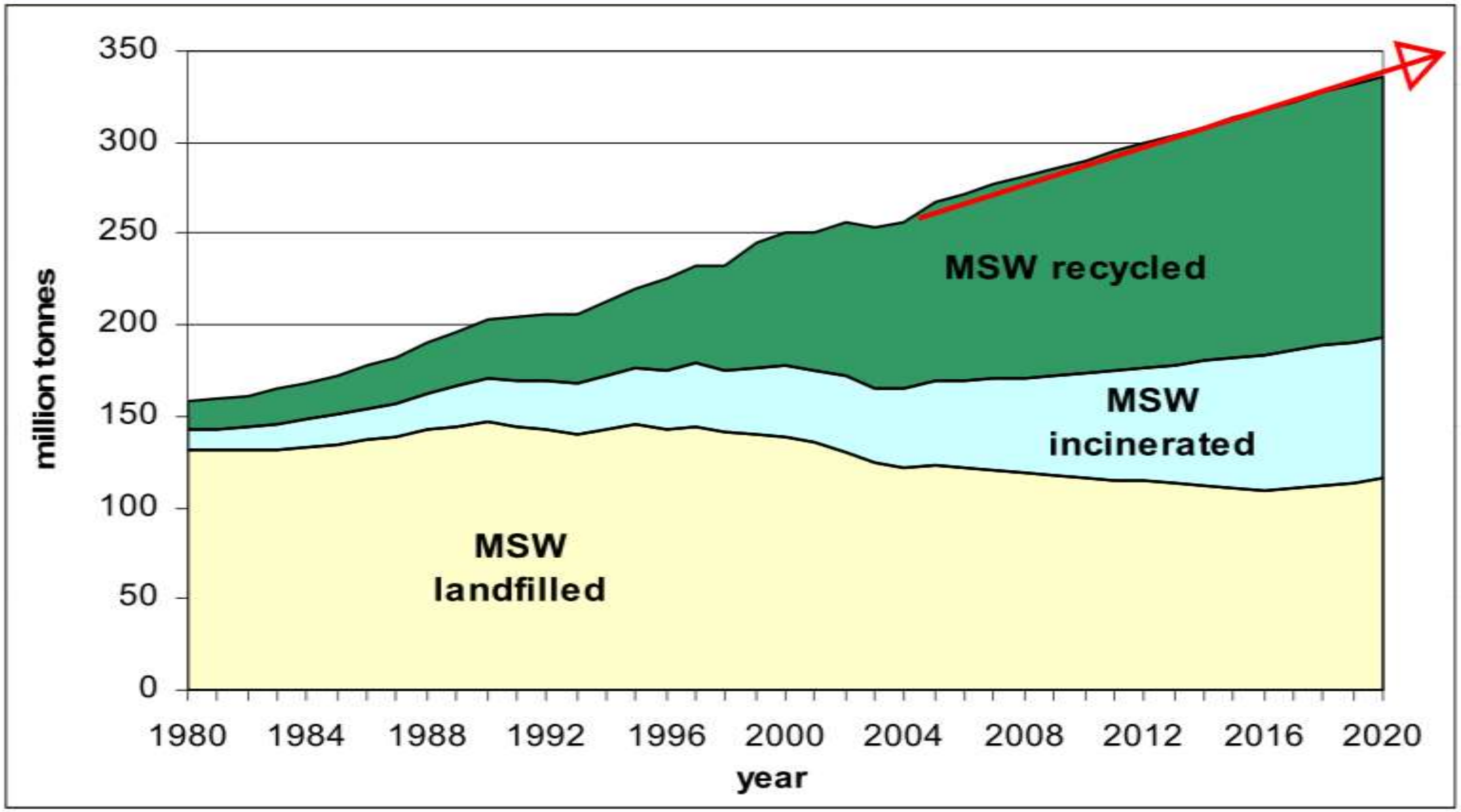
Geosofting, s.r.o., Prešov - Slovensko

„Všetci sa raz zídeme na jednom veľkom smetisku...“ (X.Y., 1992)

Figure 1-2 Aerial View of Payatas landfill (Philippines) failure (Source: Zekkos, 2005)

Projection for management of municipal waste in the EU

In 2020: landfilling 34%, incineration 23%



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Lifestyle USA

Lifestyle Mali

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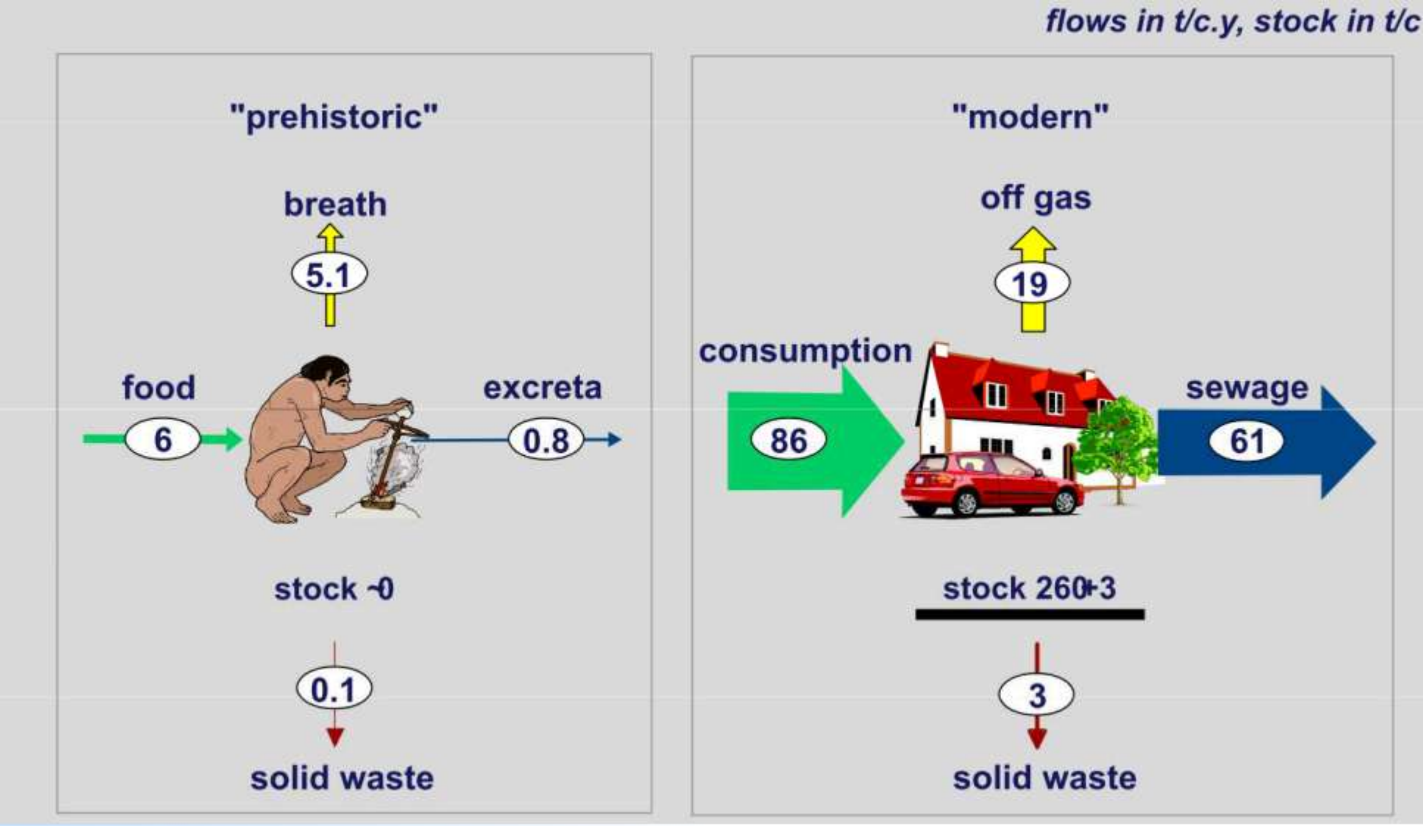
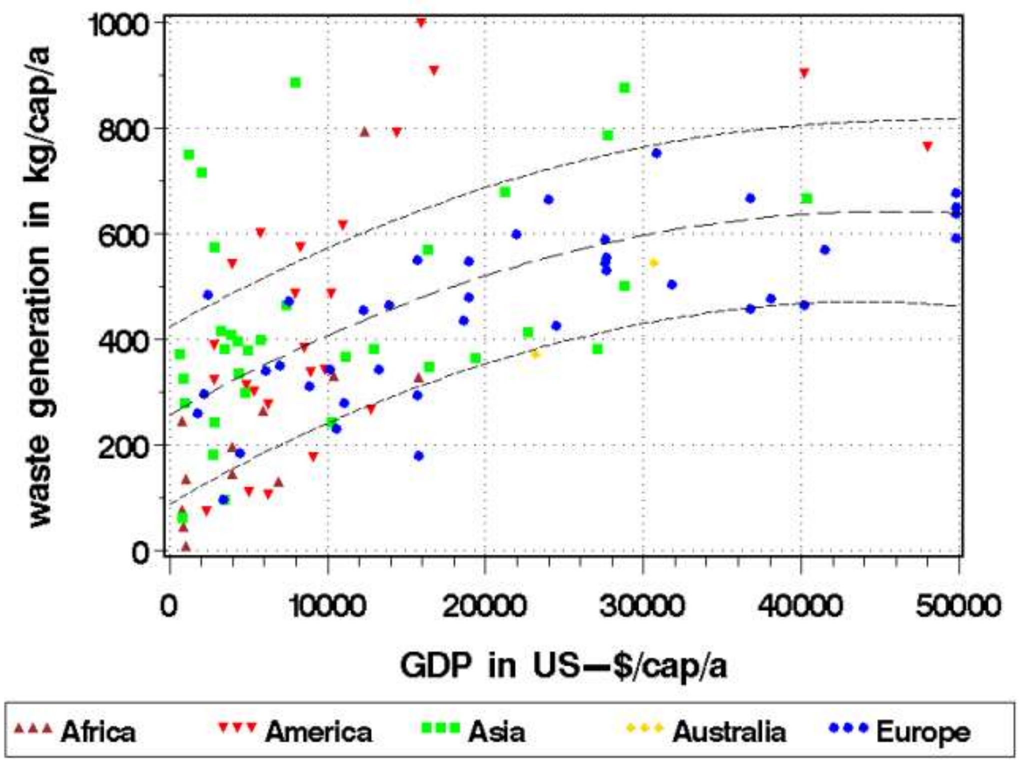
Odpady ako prirodzená súčasť URBAN METABOLISM :

-čím väčšia ekonomická aktivita,
- tým bohatšie statky,
- ale aj produkcia odpadov...



Kto nič nerobí, nič nepokazí (ale ani nič nemá !)



World

Accomplishments from IEA Bioenergy
Task 36:
Integrating Energy Recovery into Solid Waste Management Systems
(2007-2009)

Municipal Waste In The EU 1995 To 2008: Progress Towards Sustainability?

Wim Kloek, Eurostat, Luxemburg
Volker Küchen, ARGUS GmbH, Berlin
Georg F. Mehlhart, Öko-Institut e.V.

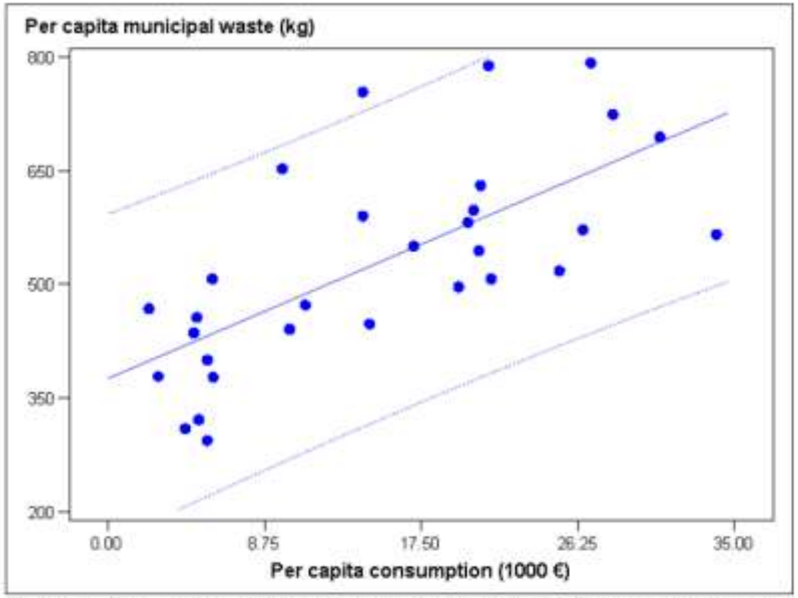


Figure 1: Regression of per capita consumption (1000 €) by per capita municipal waste (kg), 2007.

EU 27

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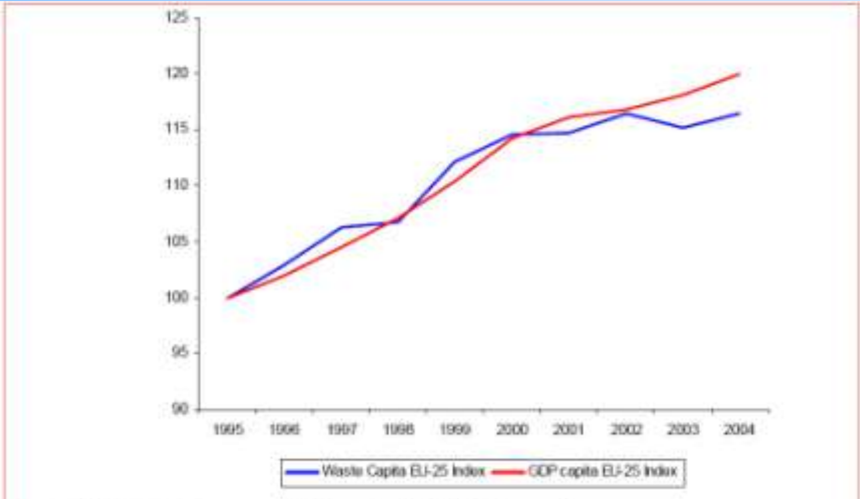


Graphic 1. Municipal solid waste and GDP per capita (1995-2005). *Source: Eurostat*

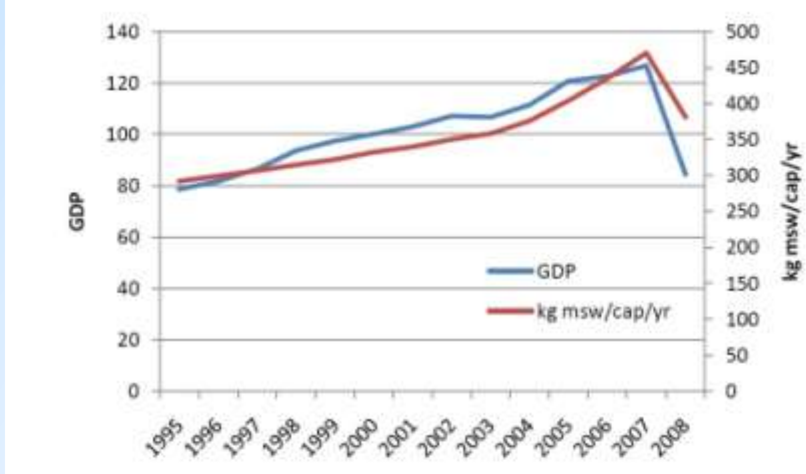
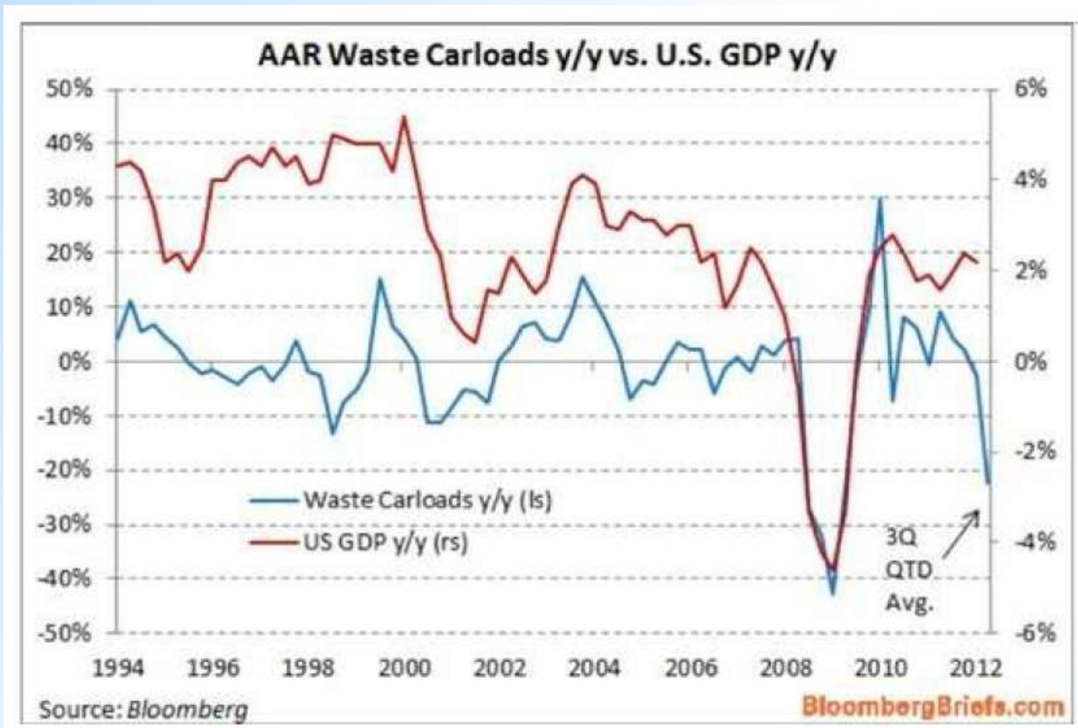


Figure 8.3 Relationship between GDP an Municipal waste generation 1994-2008



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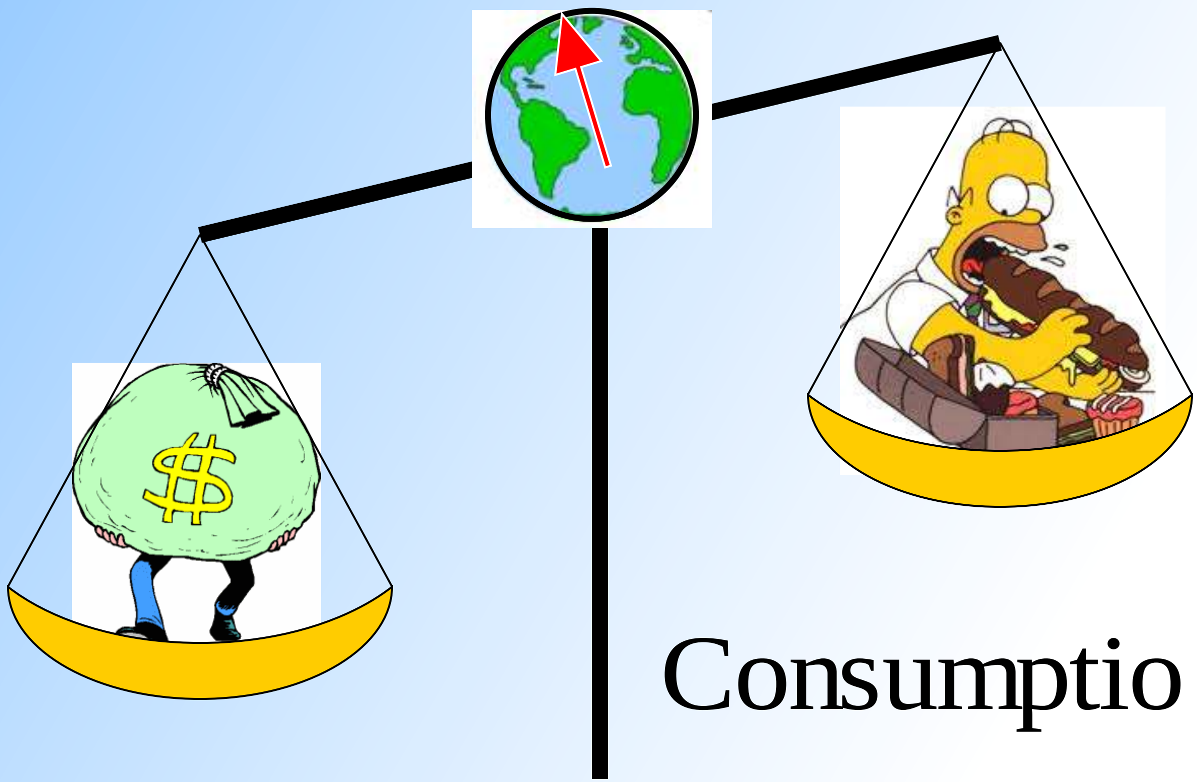
Balancing income & consumption: income elasticity

Income elasticity = b



$$\text{Consumption} = a \cdot \text{Income}^{b}$$

When income increases by **1%**, consumption increases by **b%**

Ecology, 85(7), 2004, pp. 1771–1789

TOWARD A METABOLIC THEORY OF ECOLOGY

JAMES H. BROWN,[1,2,4]
with JAMES F. GILLOOLY,[1] ANDREW P. ALLEN,[1] VAN M. SAVAGE,[2,3] AND GEOFFREY B. WEST[2,3]

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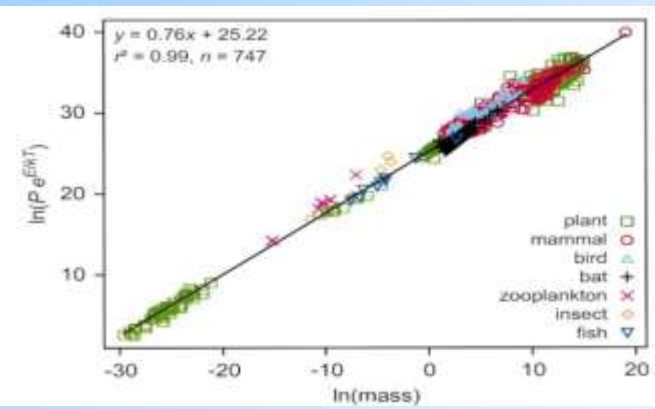
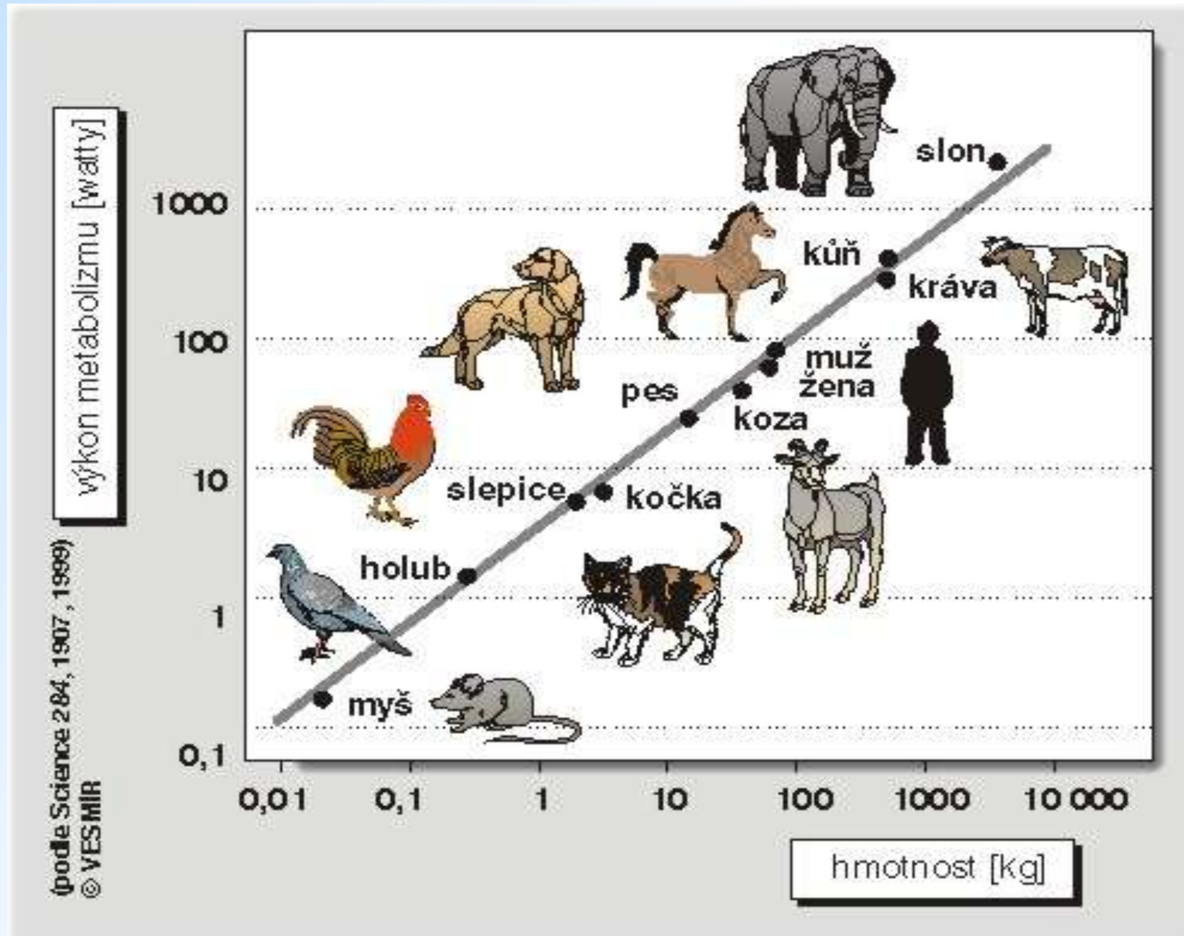
[2]*Santa Fe Institute, 1399 Hyde Park Road, Santa Fe, New Mexico 87501 USA*
[3]*Theoretical Division, MS B285, Los Alamos National Laboratory, Los Alamos, New Mexico 87545 USA*





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Energetic Limits to Economic Growth

JAMES H. BROWN, WILLIAM R. BURNSIDE, ANA D. DAVIDSON, JOHN P. DeLONG, WILLIAM C. DUNN, MARCUS J. HAMILTON, NORMAN MERCADO-SILVA, JEFFREY C. NEKOLA, JORDAN G. OKIE, WILLIAM H. WOODRUFF, AND WENYUN ZUO

A regression through the mean GDP, G for mean energy consumption and E for each country over the 24-year period, accounts for 76% of the variation. The fitted regression describes the scaling of per capita energy use with per capita GDP as a power law: $E = 4.13G^{0.76}$ (figure 1; see

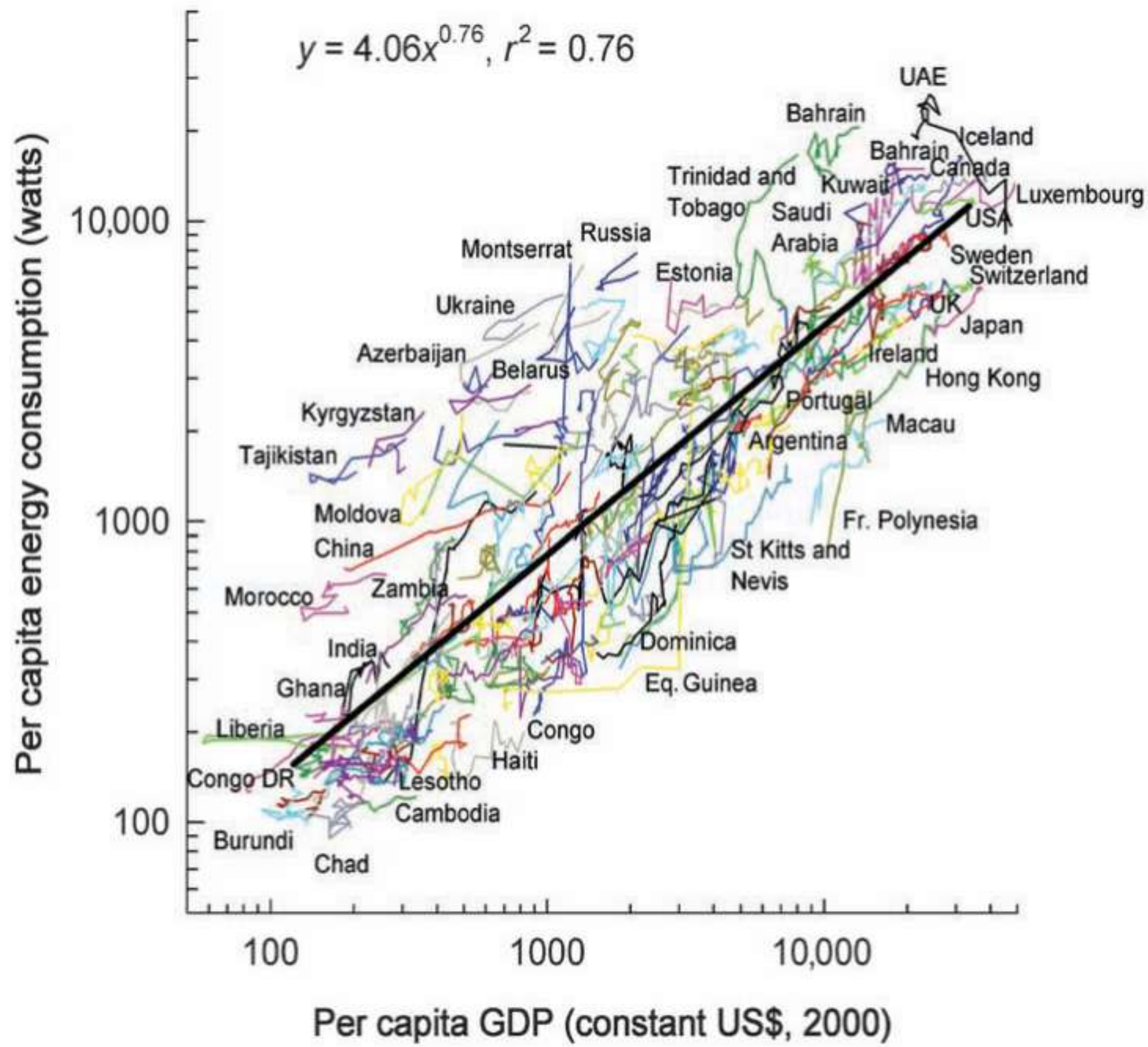
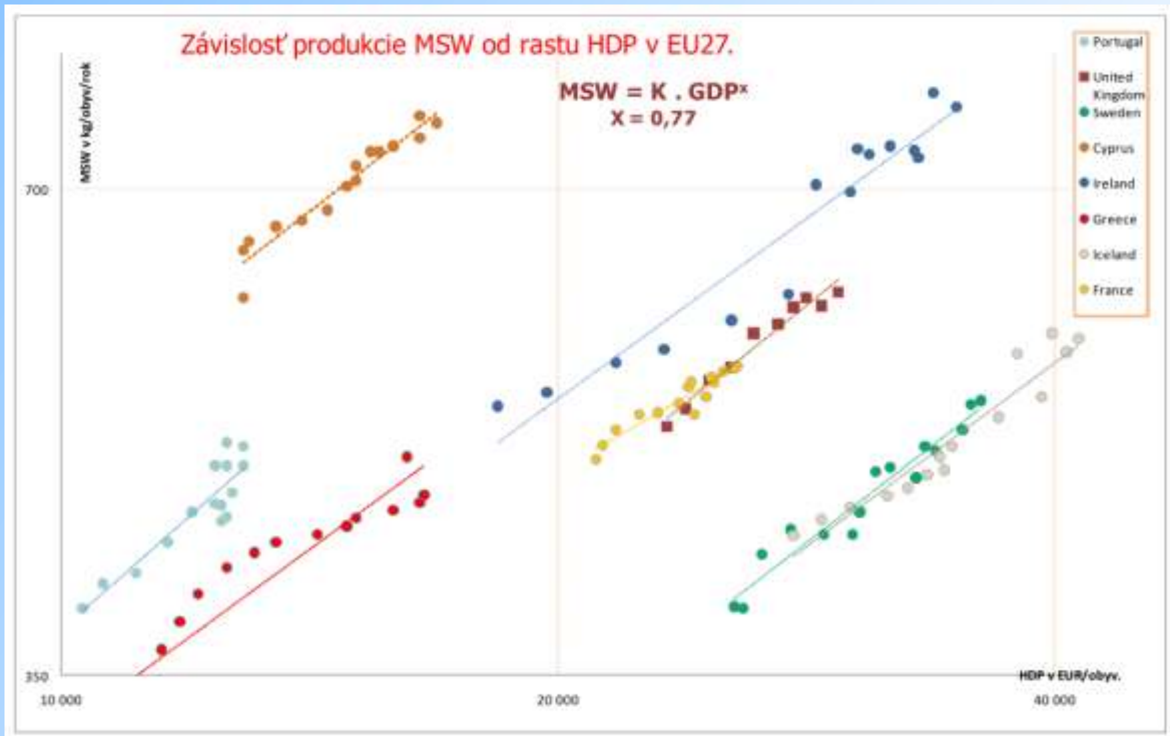


Figure 1. The relationship between per capita energy use and per capita gross domestic product (GDP; in US dollars) of countries, plotted on logarithmic axes, from 1980 to 2003. Note that the slope or exponent, 0.76 (95% confidence interval =

Waste metabolic rate (EU27)



krajina	R^2 =	MSW = K . GDP^x x =	
Norway	0,89	2,76	
Denmark	0,76	1,68	
Italy	0,78	1,44	
Switzerland	0,95	1,18	1,28
Spain	0,95	1,12	
Austria	0,68	0,98	
Portugal	0,82	0,91	
United Kingdom	0,96	0,83	
Sweden	0,94	0,79	
Cyprus	0,93	0,79	0,77
Iceland	0,92	0,76	
Greece	0,82	0,75	
Ireland	0,93	0,74	
France	0,90	0,59	
Slovakia	0,73	0,54	
Latvia	0,77	0,48	
Netherlands	0,85	0,43	
Finland	0,72	0,42	
Slovenia	0,88	0,42	0,43
Luxembourg	0,94	0,40	
Belgium	0,88	0,40	
Romania	0,59	0,40	
Czech Republic	0,75	0,39	

Definícia odpadu

Odpadom je vec, ktorej sa majiteľ chce zbaviť...

Okrem **terminologických** pojmov,

ktoré sú základom waste managementu v celej EU27 sa skoro vôbec nepracuje s

ekonomickým termínom pre odpad:

„Odpad je vec so zápornou ekonomickou hodnotou"

Smernica 2008/98/ES ustanovila hierarchiu nakladania s odpadmi - ***"waste hierarchy"****.*

ARTICLE 4 OF THE DIRECTIVE 2008/98/EC:

1. *The following waste hierarchy shall apply as a* ***priority order*** in waste prevention and management **legislation and policy**:
   - (a) *prevention;*
   - (b) *preparing for re-use;*
   - (c) *recycling;*
   - (d) *other recovery, e.g. energy recovery; and*
   - (e) *disposal.*

2. *...the best overall environmental outcome... may require specific waste streams departing from the hierarchy where this is justified by* ***life-cycle thinking***

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Stakeholder.

"Scientific Support for growth, jobs and sustainability: the example of the Eco-Industries"

Waste Management and Environmental Services

15 May 2012

FEAD

Where are new standards needed?

FEAD supports initiatives as regards standaridation (i.e. WEEE label of excellence) and encourages the development of:

- Inspection standards to fight illegal shipments;
- High quality recycling standards (i.e. End-of-Waste).
- Minimum treatment standards (art 27. WFD);

Stakeholder.

A promising European pact for growth includes priorities from the Resource Efficient Roadmap

European Day 8 May 2012

Panel discussion

The next part of the day consisted of debates between Kurt Vandenberghe (Head of Cabinet for Janez Potocnik (Environment Commissioner) at the European Commission), Bas Eickhout (MEP Green Party), John Wante (Head of Service Policy Innovation at OVAM), Jan Henk Welink (coordinator Knowledge platform Sustainable resource management, Delft University of Technology), Antje Wittenberg (Working at DG Enterprise and Industry on the European Innovation Partnership Raw Materials), Stéphane Arditi (Senior Policy Officer Waste & Products for the European Environmental Bureau) and Michel Sponar (Policy Officer at DG Environment).

Waste v. raw materials

The discussion looked at the need to maintain the distinction between waste and raw materials. The audience included Heijo Scharff (Afvalzorg), who commented: ***"We need a single set of regulations for materials."*** Vandenberghe: "That is a good idea for the longer term: many member states are far from being ready at the moment. They need regulations for waste. Don't forget that the Netherlands has an enormous advantage. ***Dutch companies can help other member states.*** The Netherlands can focus more on waste prevention and the product policy."

Landfill mining

Another important subject was that of mining in old landfills, which contain considerable quantities of raw materials. The role of the landfills also came to the fore when it came to discussing possible ways of storing waste that may be recyclable in, for example, five years from now. This was embraced as an interesting idea but one question cropped up immediately: who will make the necessary investments in view of the uncertainties surrounding the "business case"?

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EU legislatíva nepozná pojem „druhotná surovina“ !

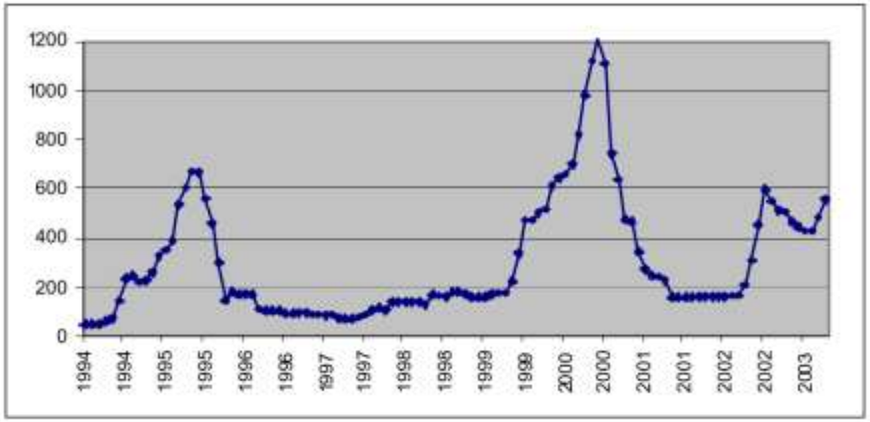
Figure 33 - Criteria of metal scrap

Prečo máme recyklovať svoje odpady ?

World price volatility of recyclable waste

Recyclable waste type	Standard deviation of price (as % of mean price)	Share of total municipal waste (%)
White paper	87	4.50
Newspaper and other paper	87	31.33
Cardboard	55	20.77
PET plastic	9	4.83
Other plastic	9	30.21
Glass	17	8.35
Total	**38**	**100**

Price index for recycled newspaper



Source: USA Bureau of Labor Statistics – Price Producer Index, Series Id: pcuso93#53.

Prečo máme recyklovať svoje odpady ?

2. Pri uplatňovaní hierarchie odpadového hospodárstva uvedenej v odseku 1 prijmú členské štáty opatrenia na podporu možností, ktoré poskytujú najlepší celkový environmentálny výsledok. To si môže vyžadovať odklon určitých odpadových tokov od hierarchie, ak je to odôvodnené úvahami o životnom cykle vo vzťahu k celkovým vplyvom vzniku a nakladania s takýmto odpadom.

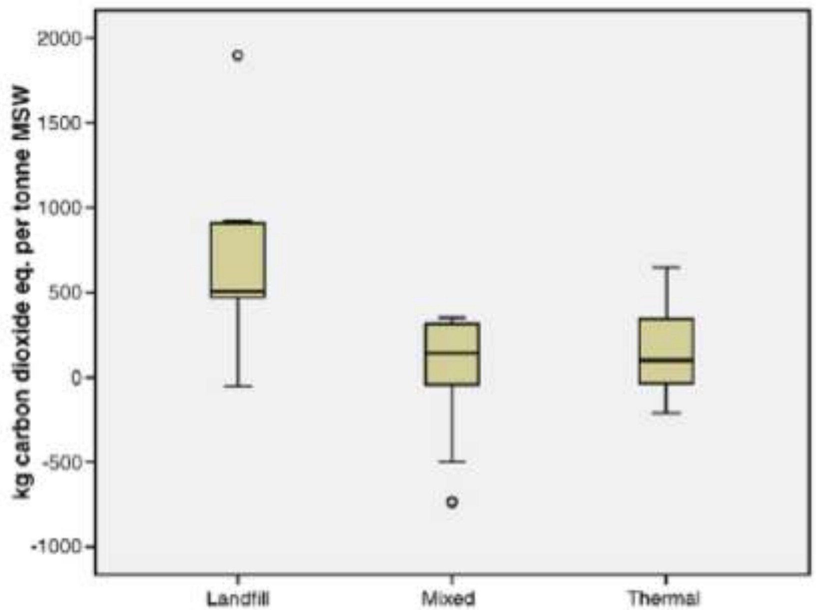


Figure 1: Statistical overview of 20 different LCA studies on MSW management systems. Mixed means recycling combined with incineration of the residual fraction.[32]

Zvíťazí dogma alebo zdravý rozum ?

Dogma alebo racionalita ?

Exploring the socio-economics of Enhanced Landfill Mining

Steven VAN PASSEL[1,*], Serge DE GHELDERE[2], Maarten DUBOIS[3,4], Johan EYCKMANS[3,4], Karel VAN ACKER[5]
[1]Hasselt University, Faculty of Business Economics, Centre for Environmental Sciences, B-3590 Diepenbeek, Belgium
[2]Futureproofed, B-3000 Leuven
[3]Hogeschool-Universiteit Brussel, B-1000 Brussels, Belgium
[4]Katholieke Universiteit Leuven, Center for Economic Studies, B-3000 Leuven, Belgium
[5]Katholieke Universiteit Leuven, Department of Metallurgy and Materials Engineering, B-3001 Heverlee, Belgium
*corresponding author: steven.vanpassel@uhasselt.be

Conceptual framework to explore the socio-economics of ELFM

As discussed in several of the other papers in this volume, most developed countries have adopted a hierarchical approach to waste management: (i) prevention and reduction of waste, (ii) recycle or reuse waste, (iii) incineration with energy recovery and if nothing else works (iv) landfilling.[5,6] A review to evaluate the impact of different waste strategies (recycling, incineration, landfilling) shows that in general recycling has the lowest impact in total energy use and global warming potential.[7] Independently of the methodology used (Life Cycle Assessment or Environmental Impact Assessment), significant environmental savings are achieved from undertaking any recycling.[8] More generally, reduced landfilling in favour of increased recycling of energy and materials leads to lower environmental impact, lower consumption of energy resources, and lower economic costs.[9] However, the price uncertainty of recycled materials is a major obstacle for recycling.[10] Taking into account the social costs (including private costs) of incineration and landfilling, landfilling can be seen as the social cost minimising option even in densely populated countries.[6] Nevertheless, not all authors come to similar conclusions, Emery *et al.*[11] showed in their Life Cycle Analysis that incineration can be preferred to landfilling and recycling. In fact, these complex trade-off issues between economic, social and environmental issues, demonstrates the need for new balanced waste management concepts and new technologies for waste valorisation. Waste valorisation is the treatment of waste for beneficial use as raw material or as an energy carrier, with the emphasis on processes and practices that reduce emissions and related environmental impacts.[12]

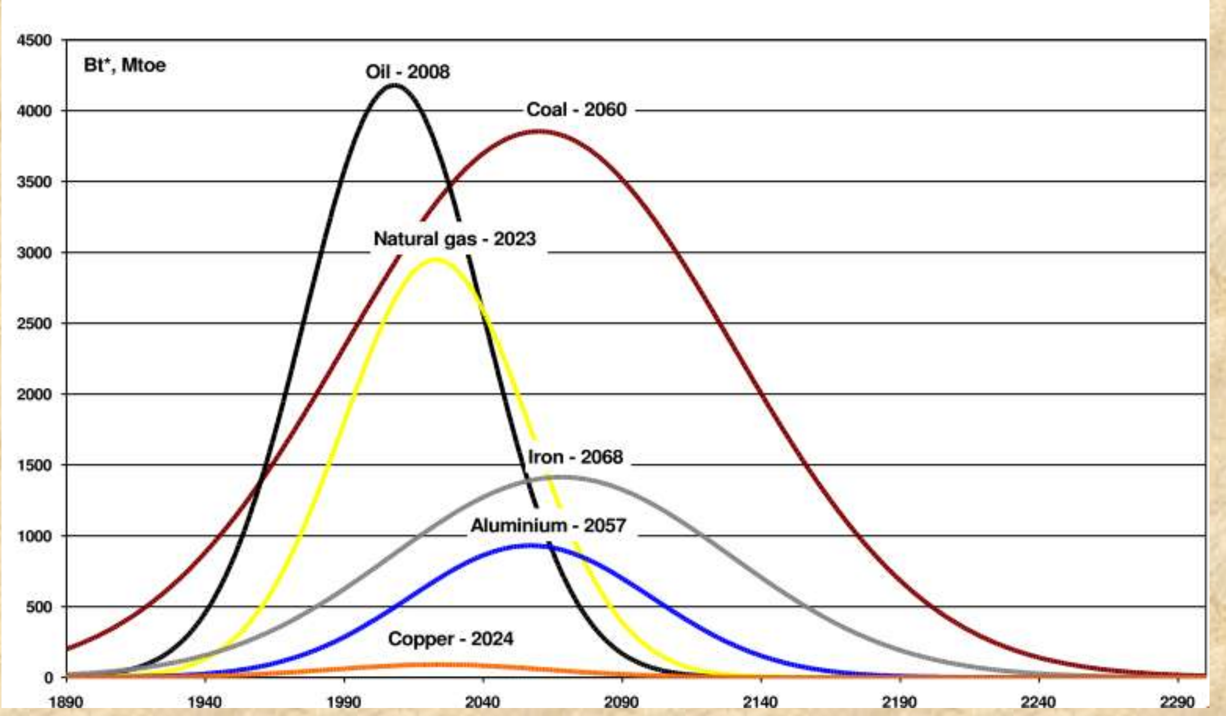
Hrozí vyčerpanie surovin ?

Critical raw materials for the EU 2010.

analyzovala 41 minerálov a kovov,

14 z nich je pre EU kritických:

antimon, berylium, fluorit, galium, germanium, grafit, indium, kobalt, Pt skupina, vzácne zeminy = REE, magnézium, niob, tantal a wolfrám



Očakávaný Hubbertov peak pre niektoré suroviny (Valera A.,2010)

Hrozí nám skutočne vyčerpanie surovín ?

Veľkosť overených zásob prírodných zdrojov je funkciou tržnej ceny tohto zdroja a prevládajúcej technológie na jeho získanie.

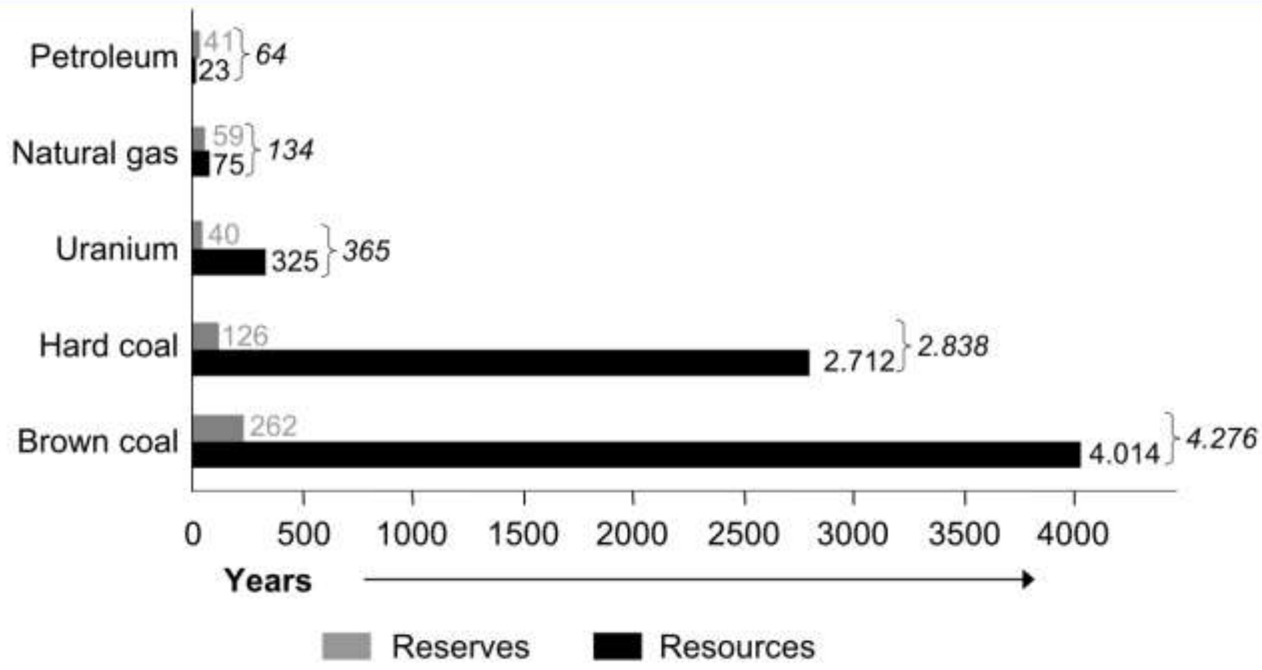
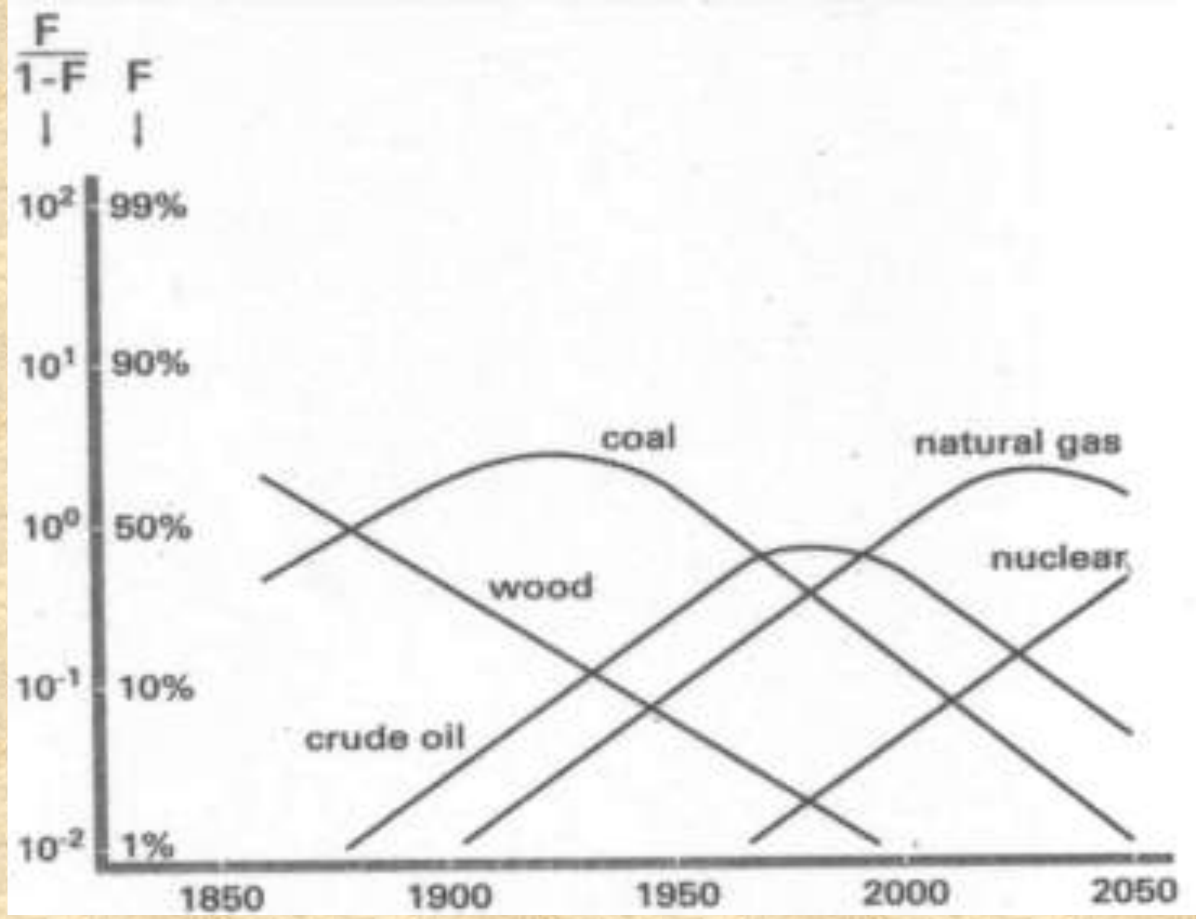


Figure 1: Static life time of non-renewable energy resources [BGR 2009]

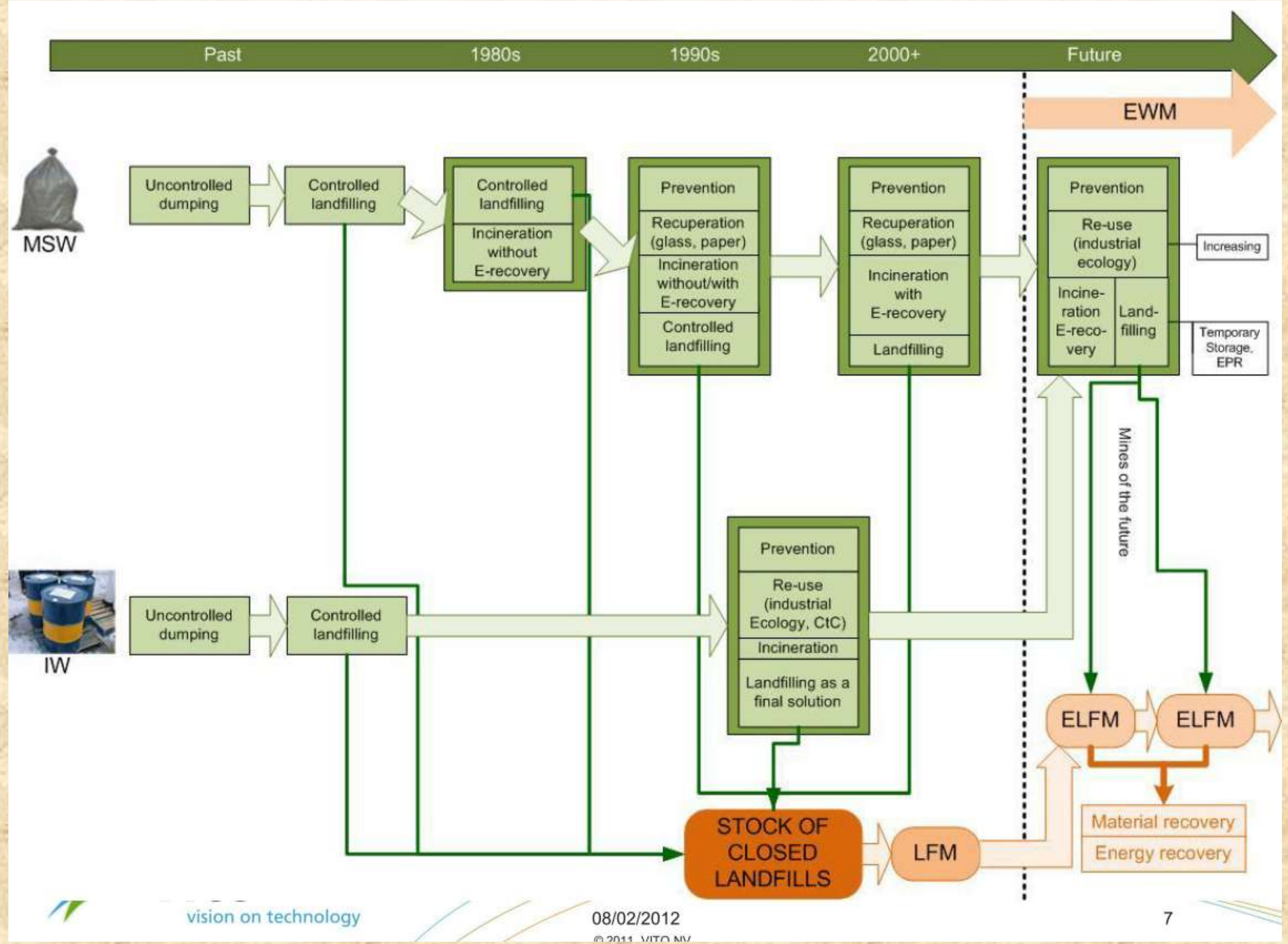
Historický pohľad na suroviny.

Hrozí nám skutočne vyčerpanie surovín ?



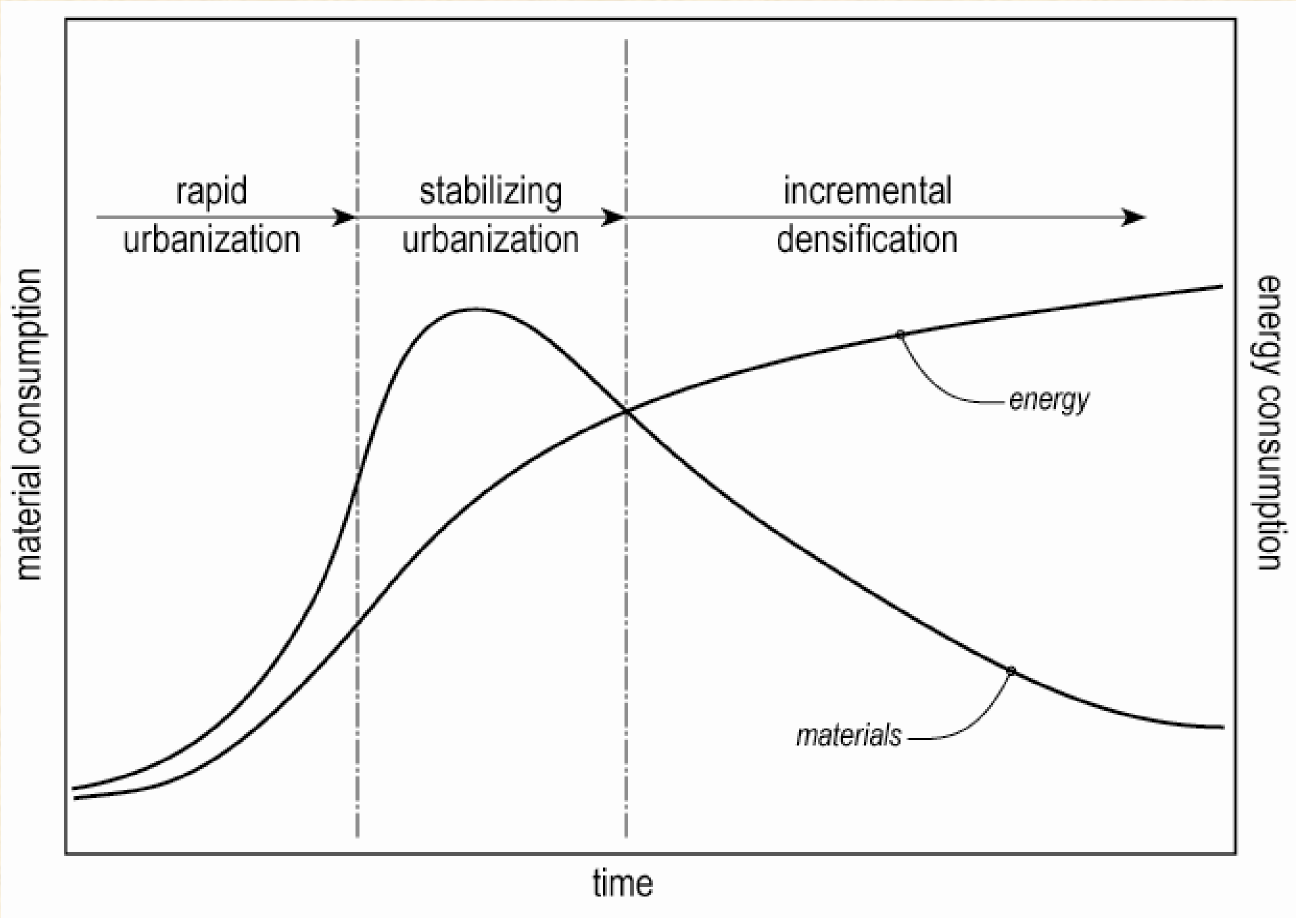
Doba kamenná neskončila pre nedostatok kameňa...
Ani stredovek pre nedostatok uhlia.

Technologický pokrok = „evolúcia“ techniky

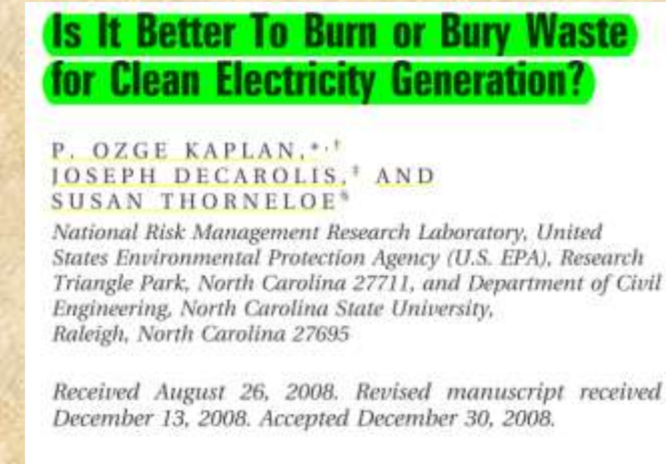


Historický pohľad na suroviny.

Spotreba surovín a energie je determinovaná hospodárskym stavom spoločnosti.



We need more - raw materials or energy ?



Is It Better To Burn or Bury Waste for Clean Electricity Generation?

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SUSAN THORNELOE*

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Received August 26, 2008. Revised manuscript received December 13, 2008. Accepted December 30, 2008.

J. P. Hannequart :

konferencia WASTE AND LIFE CYCLE THINKING, Bruxelles 5.VII.2011

„***Je poradie v článku 4 smernice 2008/98/EC správne*** ?“

Nepotrebujeme v súlade s odst. 2 tohto článku pre niektoré prúdy odpadov
najprv spracovať LCT (life-cycle-thinking),
aby sme okrem environmentálnych dopadov ako *CO_2 balance* či *Ecological Footprint*
poznali aj ekonomické dopady *Cost-Benefit Analysis, Social LCA, Life Cycle Costing* ???

We need more - raw materials or energy ?

Exploring the socio-economics of Enhanced Landfill Mining

Steven VAN PASSEL[1,*], Serge DE GHELDERE[2], Maarten DUBOIS[3,4], Johan EYCKMANS[3,4], Karel VAN ACKER[5]
[1]Hasselt University, Faculty of Business Economics, Centre for Environmental Sciences, B-3590 Diepenbeek, Belgium
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[4]Katholieke Universiteit Leuven, Center for Economic Studies, B-3000 Leuven, Belgium
[5]Katholieke Universiteit Leuven, Department of Metallurgy and Materials Engineering, B-3001 Heverlee, Belgium
*corresponding author: steven.vanpassel@uhasselt.be

Table 3: Social Cost Benefit Analysis for ELFM in Flanders

Data		
Site surface (m^2)	20 000 000	
Costs		
Total (€)	12 779 680 000	
Benefits	13 096 814 876	
Total WtM (€)	1 534 382 080	12 %
Total WtE (€)	9 937 782 556	76 %
Landfill reclamation (€)	1 368 000 000	10 %
Reduced carbon footprint	256 650 240	2 %
Total (€)	317 134 876	

Vízie EK.

EURÓPSKA KOMISIA

V Bruseli 29. 2. 2012
COM(2012) 82 final

OZNÁMENIE KOMISIE EURÓPSKEMU PARLAMENTU, RADE, EURÓPSKEMU HOSPODÁRSKEMU A SOCIÁLNEMU VÝBORU A VÝBORU REGIÓNOV

SPRÍSTUPNENIE SUROVÍN PRE BUDÚCI BLAHOBYT EURÓPY

NÁVRH EURÓPSKEHO PARTNERSTVA PRE INOVÁCIE V OBLASTI SUROVÍN

{SWD(2012) 27 final}

Geo Soft Ing, s.r.o.
EKOLOGICKÉ SLUŽBY

Vízie EK.

Podiel EÚ na celosvetovom **baníctve** sa za posledných 50 rokov podstatne zmenšil. Viedlo to k strate nevyhnutnej odbornosti a zručností. Takéto zručnosti sú však potrebné, aby sa zaistila bezpečnosť baníckych činností a aby sa splnila potenciálna rastúca potreba ťažiť hlbšie, vo vzdialenejších oblastiach a za ťažších podmienok (napr. na morskom dne, v arktickej oblasti). Vysoká úroveň bezpečnejších a ekologicky priaznivejších techník ťažby predstavuje nové výzvy a zároveň vytvára nové trhové príležitosti. Znížilo by sa tak aj riziko závažných nehôd v baníctve. Táto odbornosť a zručnosti však nie sú požadované iba v oblasti ťažby, ale v celom hodnotovom reťazci (prieskum, spracovanie, recyklácia, náhrada).

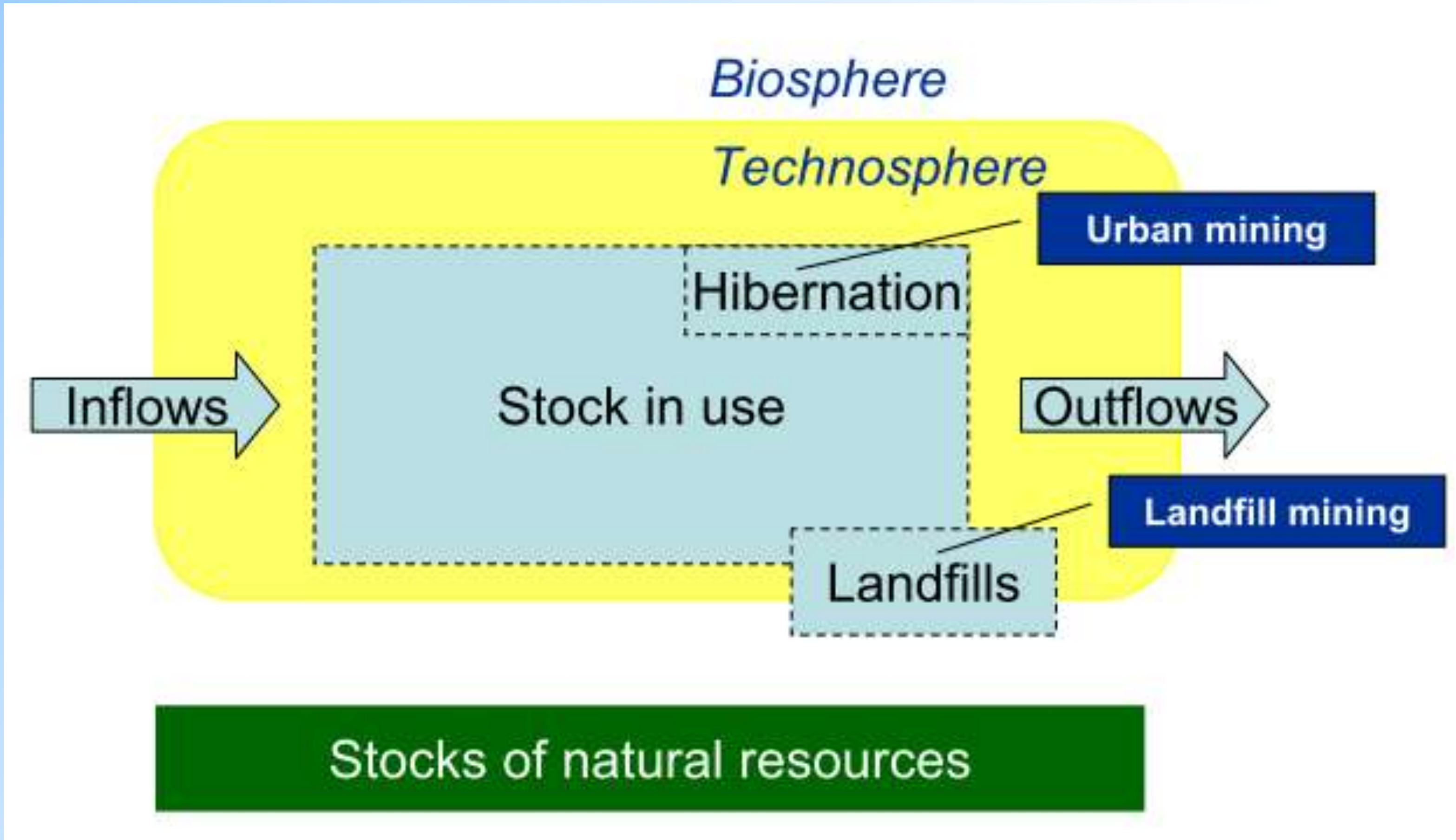
Aj keď Európa ako celok urobila významný pokrok, najmä pokiaľ ide o recykláciu odpadov, dá sa urobiť viac na zabránenie plytvania cennými surovinami vo všetkých fázach ich životného cyklu. Plným uplatnením prvých krokov európskej „hierarchie odpadov“ (prevencia, po ktorej nasleduje príprava na opakované využitie a recykláciu) by sa mohlo zabrániť nenapraviteľnej strate cenných zdrojov a mohli by sa vytvoriť nové podnikateľské a pracovné príležitosti v EÚ.

Vízie EK.

Obrovským nárastom v predaji moderných komunikačných zariadení, akými sú napríklad mobilné telefóny a prenosné počítače, ktorých miera výmeny je tendenčne vysoká, sa vytvoril enormný potenciál cenného odpadu („naše mestské bane“). Mobilný telefón sa dnes skladá z viac ako 40 rôznych surovín, ako napríklad z kobaltu, gália, platiny a vzácnych zemín. Každý občan v EÚ generuje v súčasnosti ročne okolo 17 kg odpadu z elektrických a elektronických zariadení (OEEZ), pričom sa predpovedá, že toto číslo narastie do roku 2020[9] na 24 kg. **Recyklovanie** vzácnych zemín z elektronických zariadení je však napr. veľmi náročné z technologického, ale aj ekonomického hľadiska. Separovaný zber odpadu sa musí ďalej podporovať a trhy treba povzbudiť k pokroku. Zabránenie ilegálnemu vývozu a nevhodnému spracovaniu odpadu môže okrem toho viesť k značným výhodám pre životné prostredie a k rekuperácii cenných materiálov (napr. kovový odpad, zozbieraný papier na recykláciu).

Celkovým cieľom EIP je znížiť závislosť Európy na dovoze surovín, ktoré sú kritické pre európske odvetvia. Dosiahne sa to poskytnutím dostatočnej pružnosti a alternatív pri dodávaní dôležitých surovín do Európy, pri zohľadnení dôležitosti zmiernenia negatívneho účinku niektorých materiálov počas ich životného cyklu na životné prostredie, a čím sa z Európy stane svetový líder v spôsobilostiach týkajúcich sa prieskumu, ťažby, spracovania, recyklácie a náhrady do roku 2020. Od EIP sa očakáva, že v rámci svojho strategického vykonávacieho plánu (SIP) stanoví ciele vplyvu na meranie úspechu, napríklad pokiaľ ide o veľké zníženie závislosti na dovoze niektorých z najkritickejších surovín.

Urban and Landfill mining.



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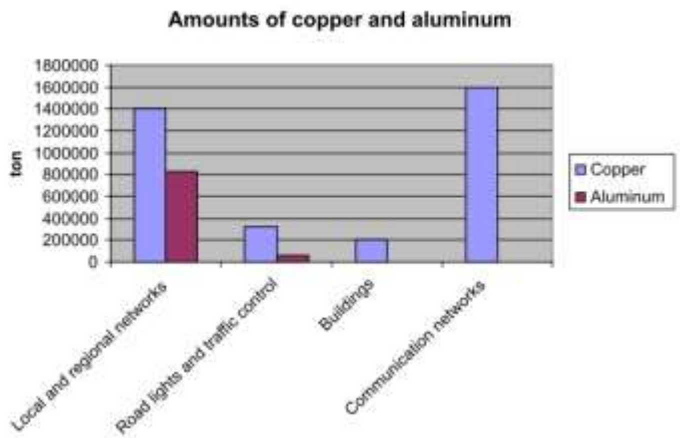
Urban and Landfill mining.

Total stock of cables in operation



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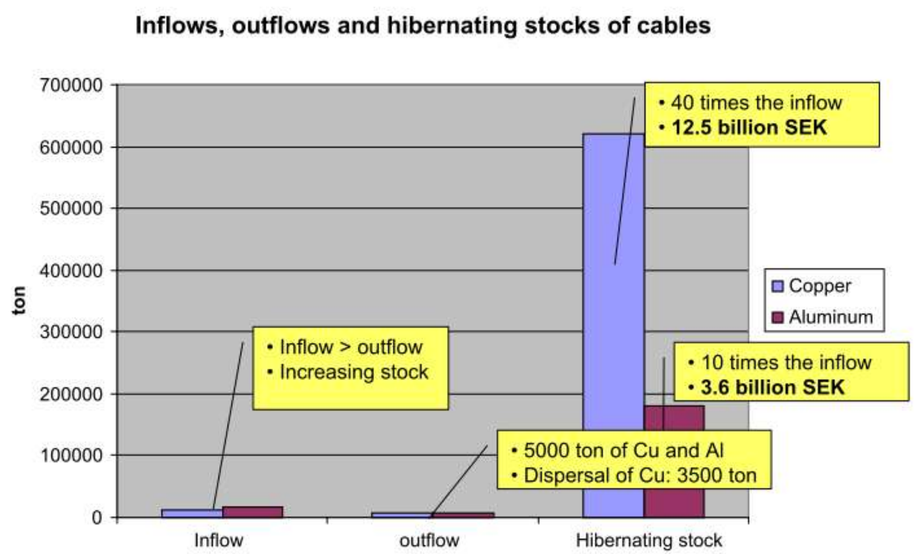
Linköping University

The potential for urban mining



- Large potential for increased recycling of cables
  - Inflow larger than the outflow: increasing stocks
  - The main part is buried in soil: a need for development of new technologies
- Communication cables (transport-network) display the greatest potential for urban mining
  - Large hibernating stocks
  - Highest concentration per meter cable
- Large economic value of cable in hibernation
  - A total material value of more than **16 billion SEK**

= 1,863 mld. EUR !

Urban and Landfill mining.

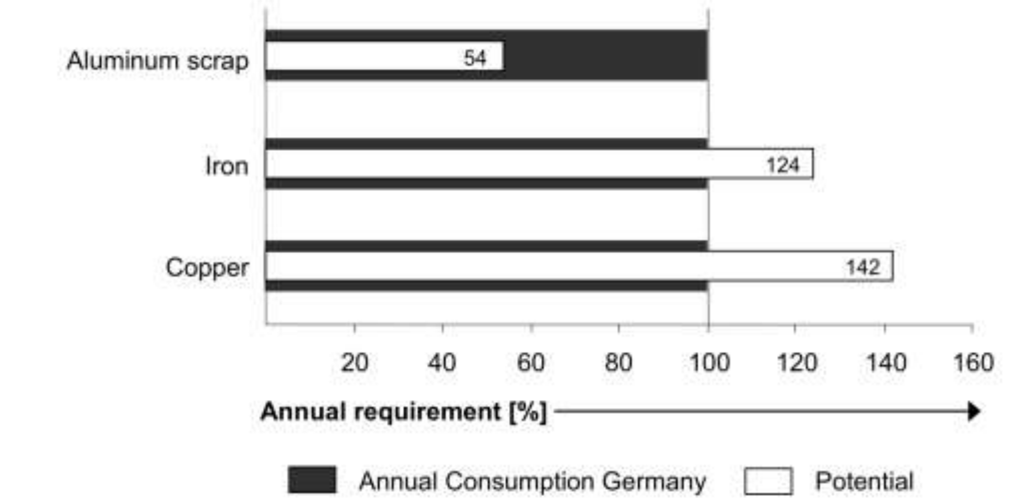


Figure 5: Potential of raw materials contained in German waste dumps related to the annual requirements of the German Federal Republic [Rettenberger 2009]

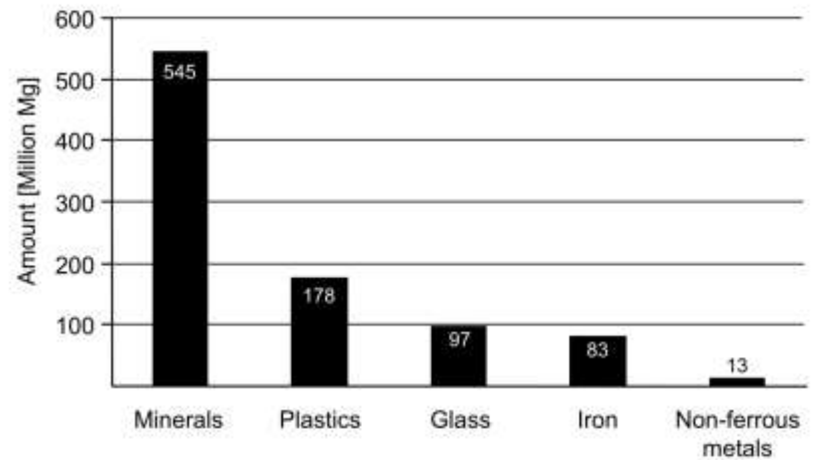


Figure 4: Estimation of quantities of individual groups of materials on waste dumps in Germany [Mocker et al. 2009]

Resource Potential of Landfill Mining – A National and Regional Evaluation

Dr.-Ing. Matthias Franke, Dr. Mario Mocker, ATZ Entwicklungszentrum,

URBAN mining – „spiace suroviny“ v elektronike.

Metal		World Mine Production, 2007 (t/yr)	Demand from Electronics Sector (t/yr)	Electronics sector demand/mine production	
Silver	Ag	20,000	6,000	30%	
Gold	Au	2,500	250	10%	
Palladium	Pd	215	32	15%	
Platinum	Pt	220	13	6%	
Ruthenium	Ru	30	6	20%	
Copper	Cu	16,000,000	4,500,000	28%	
Tin	Sn	275,000	90,000	33%	
Antimony	Sb	130,000	65,000	50%	!!!
Cobalt	Co	58,000	11,000	19%	
Bismuth	Bi	5,600	900	16%	
Selenium	Se	1,400	240	17%	
Indium	In	480	380	79%	!!!

Source: Christian Hageluken, Umicore Precious Metals Refining, presentation at the Basel Convention, Geneva Switzerland, 7 Sept. 2007.

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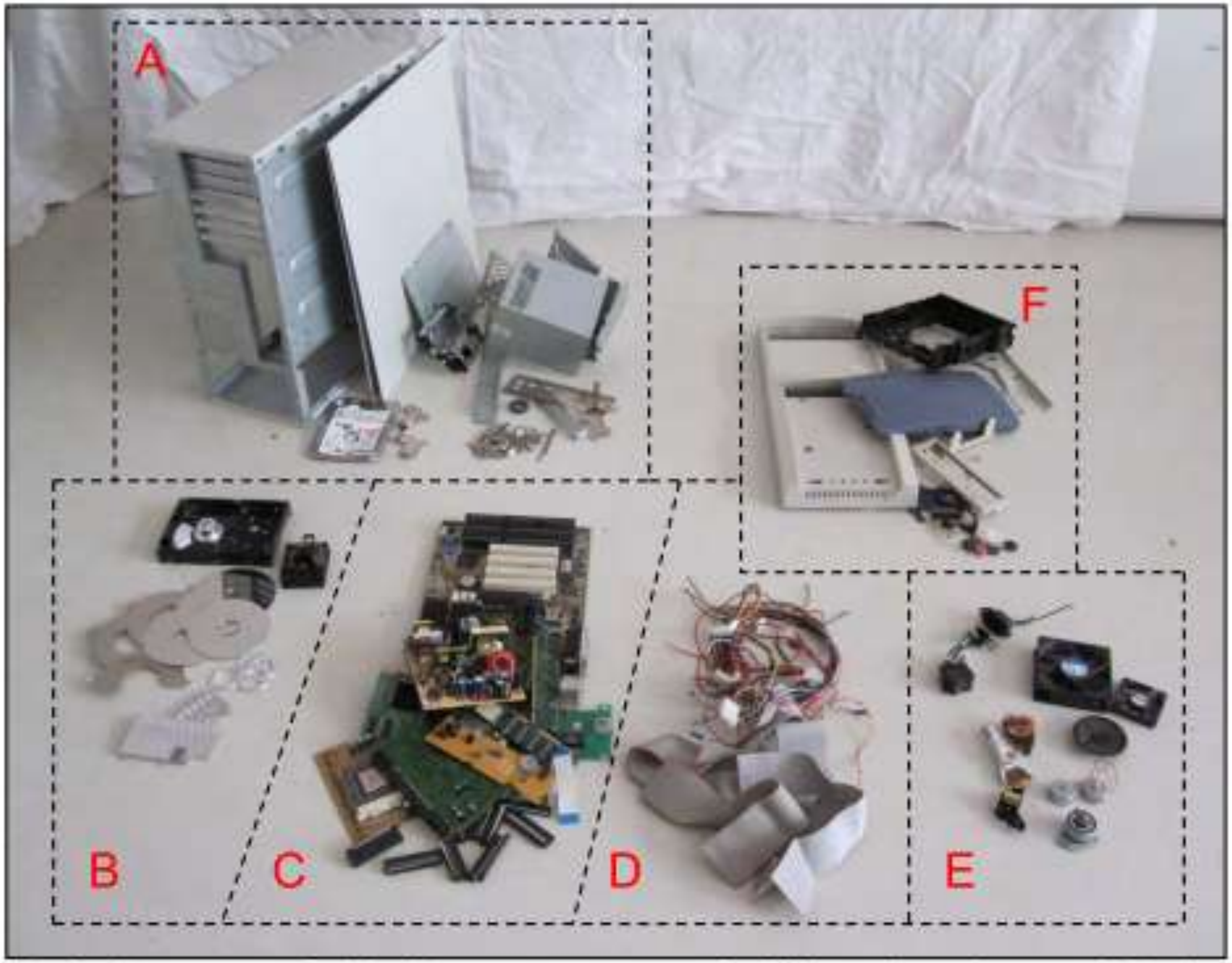
Odpad či surovina ?

Critical raw materials for the EU 2010.



A = Steel scrap
B = Aluminium scrap
C = High-grade precious metals fraction
D = Copper cables
E = Low-grade copper fraction
F = Plastic fraction

Odpad či surovina ?

Critical raw materials for the EU 2010.

Öko-Institut e.V.
Institut für angewandte Ökologie
Institute for Applied Ecology

Verlorene Sekundär-Ressourcen: Notebooks

31 mil. €

Metall		Gehalt in allen 2010 in D verkauften Notebooks [t]	Verluste bei der			Rückgewinnung in Deutschland [t]
			Erfassung	Vor-behandlung	End-behandlung	
Kobalt	Co	461,31	50%	20%	4%	177
Neodym	Nd	15,16		100%	100%	0
Tantal	Ta	12,06		100%	5%	0
Silber	Ag	3,11		70%	5%	0,443
Praseodym	Pr	1,94		100%	100%	0
Gold	Au	0,74		70%	5%	0,105
Dysprosium	Dy	0,43		100%	100%	0
Indium	In	0,29		20%	100%	0
Palladium	Pd	0,28		70%	5%	0,040
Platin	Pt	0,028		100%	5%	0
Yttrium	Y	0,012		40%	100%	0
Gallium	Ga	0,010		40%	100%	0
Gadolinium	Gd	0,0048		40%	100%	0
Cer	Ce	0,00069		40%	100%	0
Europium	Eu	0,00028		40%	100%	0
Lanthan	La	0,00008		40%	100%	0
Terbium	Tb	0,00003		40%	100%	0

Quelle: NRW, LANUV-Fachbericht 38 (Öko-Institut 2012: Recycling kritischer Rohstoffe aus Elektronik-Altgeräten)

Odpad či surovina ?

Critical raw materials for the EU 2010.

Ako sa uvádza v štúdii EK, **jedna tona mobilov obsahuje zhruba 300 – 350 g zlata, 140 g platiny a paládia a asi 70 kg medi.**

Pritom štáty EU dnes recyklujú v priemere len asi 2 % mobilov !

Odpad či surovina ?

Critical raw materials for the EU 2010.

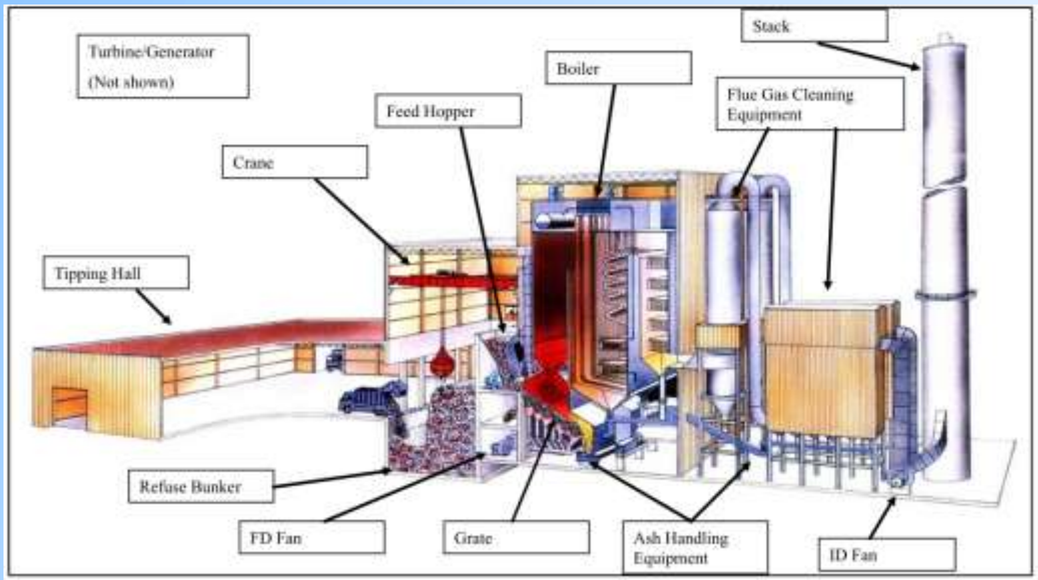
V roku 2009 bolo v Ghane v rámci dovozu WEEE približne 70 % ako použité zariadenia,
30 % dovozu boli odhadované ako nefunkčné zariadenia = teda e-odpad !.
Tento dovoz vyprodukuje len v roku 2010 asi 40.000 ton elektronického odpadu.

cca 54 520 000 $

	Amount contained in a desktop computer [g/unit]	Average material price 2007 [US$/t]	Intrinsic material value 2007 [US$/unit]	Estimated recovery rates with presently applied technology	Estimated recovery rates with best applicable technology	Net material value with presently applied technology [US$/unit]	Net material value with best applicable technology [US$/unit]
Steel	6,737.50	253*	1.70	95%	95%	1.62	1.62
Plastics	1,579.55	310**	0.49	0%	0%	0	0
Aluminium	550.21	2,700	1.49	88%	78%	1.31	1.16
Copper	413.225	7,231	2.99	85%	98%	2.54	2.93
Zinc	25.94	3,400	0.09	0%***	0%***	0	0
Tin	19.57	19,800	0.39	0%	0%***	0	0
Antimony	18.58	5,660	0.11	0%	0%***	0	0
Nickel	12.70	37,200	0.47	0%***	0%***	0	0
Lead	6.59	2,730	0.02	0%	0%***	0	0
Neodymium	5.87	100,000****	0.59****	0%***	75%*****	0	0.44*****
Silver	1.70	550,000	0.94	0%	87%	0	0.81
Gold	0.26	22,400,000	5.82	30%	93%	1.75	5.42
Palladium	0.12	11,488,748	1.38	0%	91%	0	1.25
Chromium	0.02	2,010	0.00	0%***	0%***	0	0
Ceramics & others	366.04	-	-	-	-	-	-
Sum	**9737.87**		**15.88**			**7.22**	**13.63**

Použité PC ako odpad = zdroj dôležitých surovín.

Energetická hodnota odpadu.



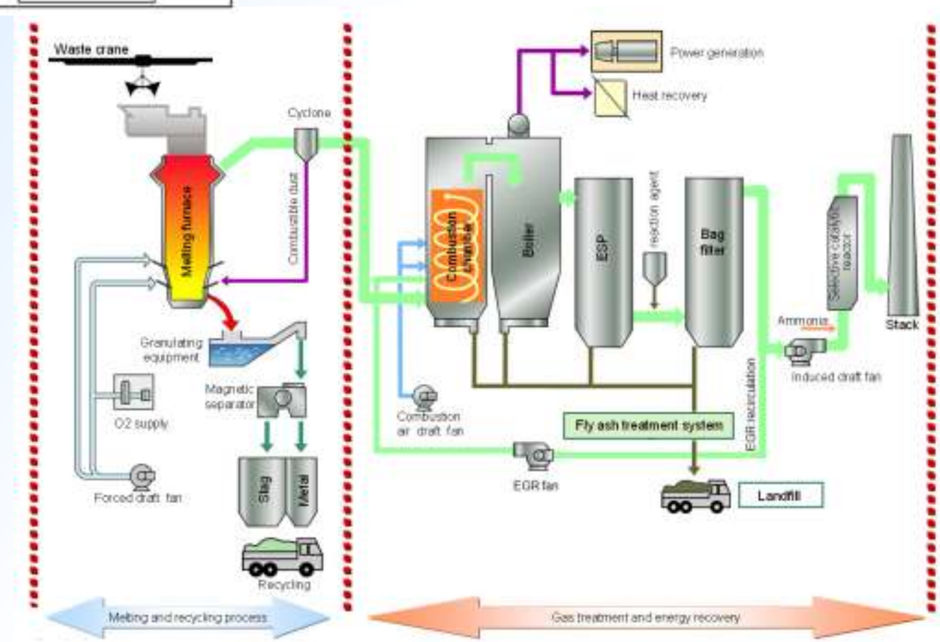


Fig. 1. Process diagram.

Energetická hodnota odpadu.

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Table 1. MSW average composition.

MSW average composition	C % d.b.	H % d.b.	O % d.b.	N % d.b.	S % d.b.	Ashes % d.b.	H_2O %w.b.	L.C.V. w.b. kJ/kg
Paper	44.80	6.00	43.30	0.24	0.16	5.50	15.00	12,100
Cardboard	43.85	6.00	45.00	0.25	0.20	4.70	12.50	13,100
Other cellulosic	52.24	7.70	37.83	0.15	0.09	1.99	20.00	11,500
Textiles	52.00	6.30	35.83	3.20	0.17	2.50	20.00	14,200
Wood	50.00	6.00	42.32	0.20	0.08	1.40	22.00	13,800
Plastic	61.60	8.50	17.40	2.30	0.20	10.00	6.00	28,300
Rubber	81.20	9.00	0.00	0.90	0.90	8.00	2.00	20,800
Glass and inerts	3.00	0.40	0.40	0.15	0.05	96.00	2.50	0
Metals	4.50	0.60	4.28	0.07	0.05	90.50	4.00	0
Domestic organic waste	48.00	6.00	34.00	2.18	0.32	9.50	70.00	2,100
Cuttings and prunings	47.00	6.20	37072	2.85	0.23	6.00	50.00	6,040
Organic waste	48.00	6.17	34.10	2.40	0.33	9.00	70.00	2,100
Undersize	26.35	5.50	30.50	2.50	0.15	35.00	30.00	5,400

Type of Thermal Process Technology	Net Energy Production to Grid
Mass Burn (Incineration)	493 kWh/tonne MSW (544 kWh/ton MSW)
Pyrolysis	518 kWh/tonne MSW (571 kWh/ton MSW)
Pyrolysis/Gasification	621 kWh/tonne MSW (685 kWh/ton MSW)
Conventional Gasification	621 kWh/tonne MSW (685 kWh/ton MSW)
Plasma Arc Gasification	740 kWh/tonne MSW (816 kWh/ton MSW)

Table 2. Thermal Process Technology and Net Energy to Grid

Energetická hodnota odpadu.

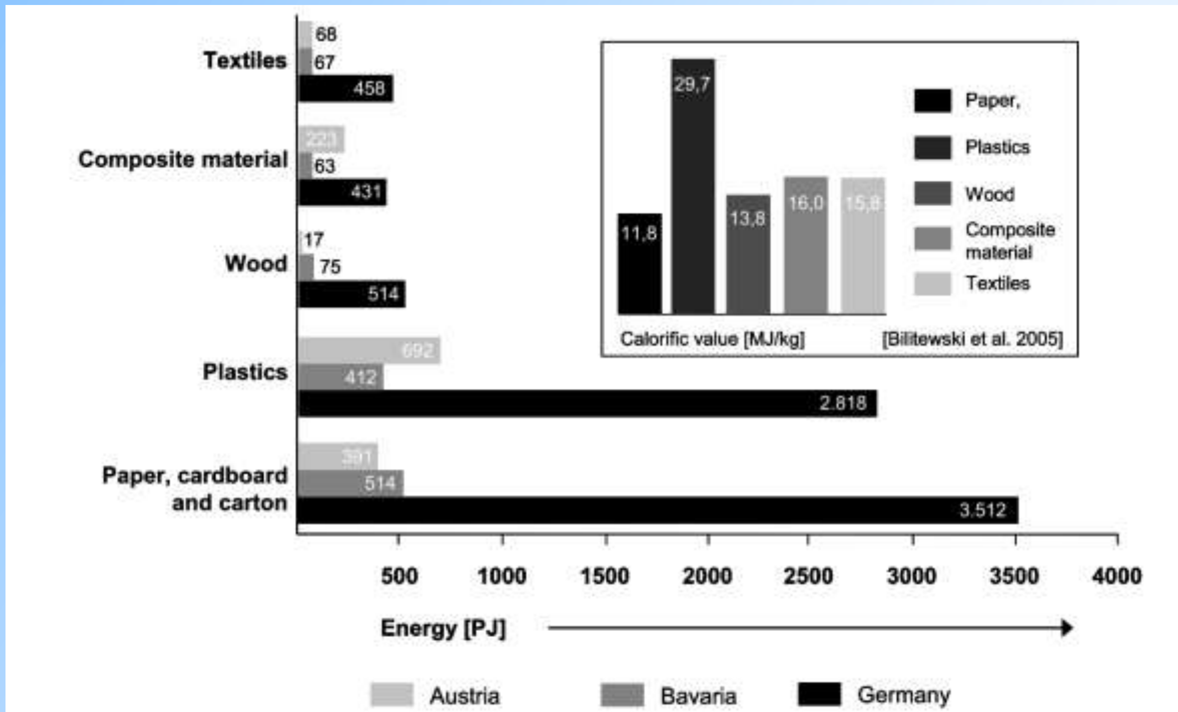
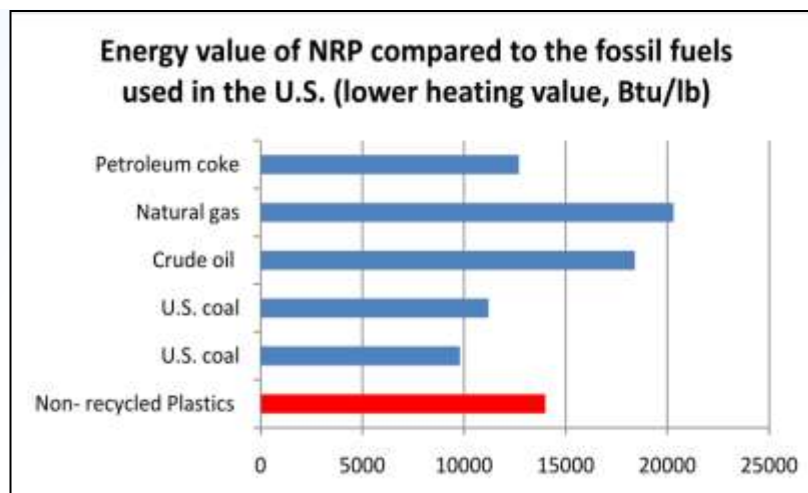


Figure 7: Estimation of the energy potential of the high calorific content materials for waste dumps in Germany, Bavaria and Austria



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Vítr má potenciál pokrýt polovinu světové spotřeby energie v roce 2030

Energie větru by mohla uspokojit až polovinu světové poptávky po elektřině v roce 2030. Přitom na její pokrytí stačí instalace čtyř milionů turbín, které by měly výkon 7,5 TW. Tvrdí to společná studie amerických vědců z univerzit v Delawere a Stanfordu, která vypočítala celkový potenciál větrné energie v planetárním měřítku.

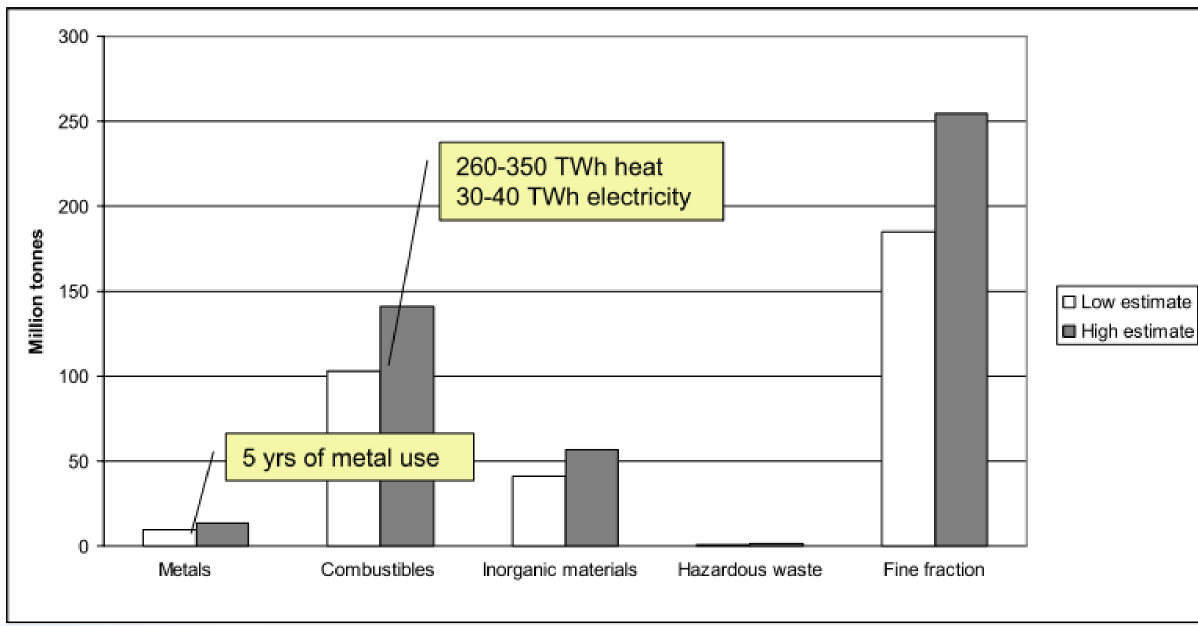
1,5 MW veterná turbína vyžaduje asi 350 kg prvkov vzácnych zemín (REE)

Na 7,5 TW potrebujeme cca 1 750 000 ton REE !

Súčasná celosvetová ročná ťažba je cca 124 000 ton
t.j. 14 rokov ťažby...

Podle Archerové a Jacobsona by instalace čtyř milionů turbín měla mít výkon až 7,5 TW,

Amount of material in Swedish landfills



Landfill mining.

Definition and objectives of LFM

- A process of excavating landfills using conventional surface mining technologies
- Excavation, processing, recycling and/or treatment of waste in landfills
- Objectives
  - Conservation of landfill space
  - Upgrading to state-of-the-art landfills (decreasing operational costs, regulations)
  - Pollution prevention and remediation
  - Site re-development (regain land for other uses)
  - Recovery of material and energy resources

Landfill mining.

LANDFILL MINING: A REVIEW OF THREE DECADES OF RESEARCH

Joakim Krook*, Niclas Svensson, Mats Eklund, Nils Johansson, Per Frändegård

Department of Management and Engineering, Environmental Technology and Management, Linköping University, SE-581 83 Linköping, *joakim.krook@liu.se, +46 13 288903

Abstract

Landfills have historically been seen as the ultimate solution for storing waste at minimum cost. It is now a well-established fact however that such deposits have related implications such as long-term methane emissions, local pollution concerns and limitations on urban development. Landfill mining has been suggested as a strategy to address such resource and pollution problems and in principle means the excavation, processing, treatment and/or recycling of deposited materials. This study involves a literature review on landfill mining covering an analysis of trends, objectives and research topics in 39 papers published during the period 1988–2008. The results show that so far landfill mining has primarily been seen

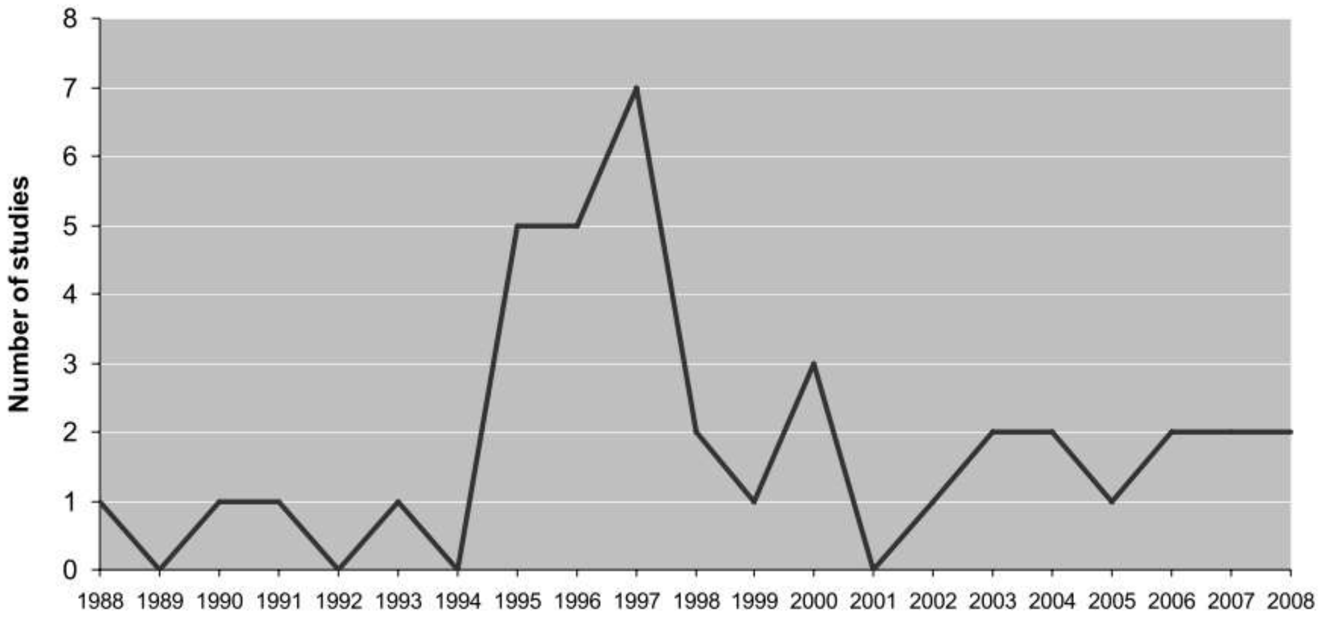
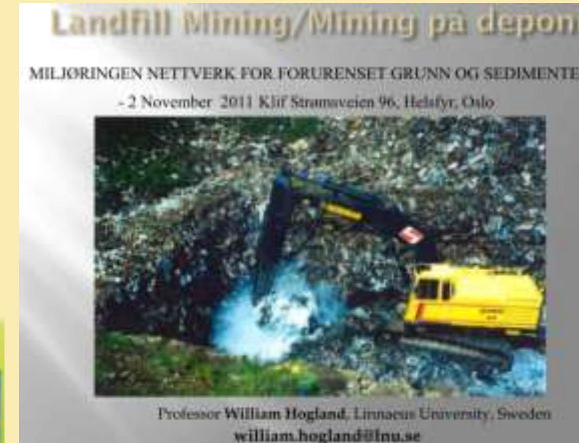


Figure 1. Research intensity on landfill mining over time presented as number of published papers per year. The total number of papers included in the figure is 39.

Landfill mining.



V rokoch 2010-2012 sa uskutočnilo už 6 konferencii s vyše 50 príspevkami...

Landfill mining.

Mining Project Hunts Treasure in Old Landfills

Contributor: The Clean Mining Alliance .
Posted: 08/16/2012 12:00:00 AM EDT | 0

Rate this Article: (4.0 Stars | 1 Vote)

Tags: Landfill | mines | Remo Milieubeheer landfill site | Belgium | Clean Mining Alliance

Resource Potential of Landfill Mining – A National and Regional Evaluation

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Landfill mining: filling a gap or just creating a big hole?

Riverside Waste managing director Chris Oldfield shares his view on landfill mining

Without fail, the word 'landfill' appears in the media numerous times a day.
This is because the UK is now highly committed to preventing valuable to recover and recycle millions of tonnes of irresponsibly landfilled waste, and in many instances use these buried resources as renewable energy fuels.
Metals and plastics can be separated, cleaned and mechanically recycled, and because plastics are made from oil they can even be used to harness energy using gasification or

Exploring the socio-economics of Enhanced Landfill Mining

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*corresponding author: steven.vanpassel@uhasselt.be

Abstract

This paper explores the socio-economics of Enhanced Landfill Mining (ELFM). A conceptual framework including performance drivers is presented. Technology (Waste-to-Energy (WtE) and Waste-to-Material (WtM) technologies), regulation (subsidies, taxes, allowances…) and markets (energy, material prices and input costs) determine the economic performance of ELFM. Using a case study, an investment model is developed to identify the impact of a broad range of parameters on the profitability of ELFM. Especially variations in WtE

Enhanced Landfill Mining: Material recovery, energy utilisation and economics in the EU (Directive) perspective

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[2]LundaHydro AB, Vårlöksvägen 4, SE-387 92 Borgholm, Sweden
william.hogland@lnu.se, marikahogland@gmail.com

Technologický vývoj v procese skládkovania

Zdroj: J. Kurian, 2002

MAX

Environmentálny dopad na okolie

Min

Table 1 Types of Landfills

Type	Engineering measures	Leachate management	Landfill Gas Management	Operation measures
Open Dumps	None	Unrestricted contaminant release	None	Few, scavenging
Controlled Dump	None	Unrestricted contaminant release	None	Registration and placement/ compaction of waste
Engineered Landfill	Infrastructure and liner in place	Containment and some level of leachate management	Passive ventilation or flaring	Registration and placement/ compaction of waste; uses daily soil cover
Sanitary Landfill	Proper siting, infrastructure; liner and leachate treatment in place	Containment and leachate treatment (often biological and physico-chemical treatment)	Flaring	Registration and placement/ compaction of waste; uses daily of soil cover, Measures for final top cover
Controlled Contaminant Release Landfill	Proper siting, infrastructure, with low-permeability liner in place. Potentially low-permeability final top cover	Controlled release of leachate into the environment, based on assessment and proper siting	Flaring or passive ventilation through top cover	Registration and placement/ compaction of waste, uses daily soil cover. Measures for final top cover
Landfill Bioreactor	Proper siting, infrastructure, liner and leachate recirculation/ generation system	Controlled recirculation of leachates for enhanced degradation and stabilization of wastes and leachates	Landfill Gas recovery	Registration and placement/ compaction/ daily cover/ closure/ mining and material recovery

Min

Investičné a prevádzkové náklady

MAX

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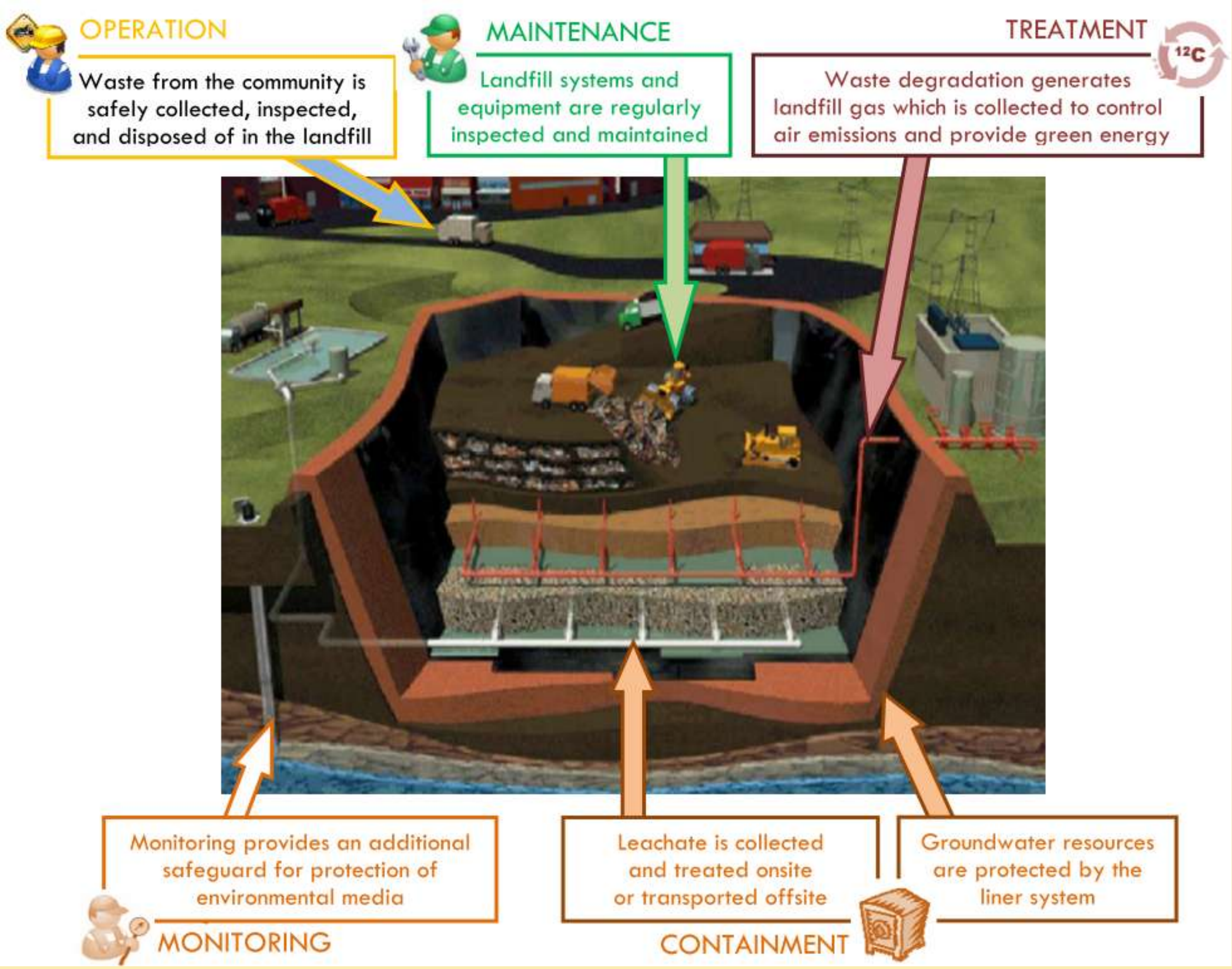
EKOLOGICKÉ SLUŽBY

Sustainable landfill

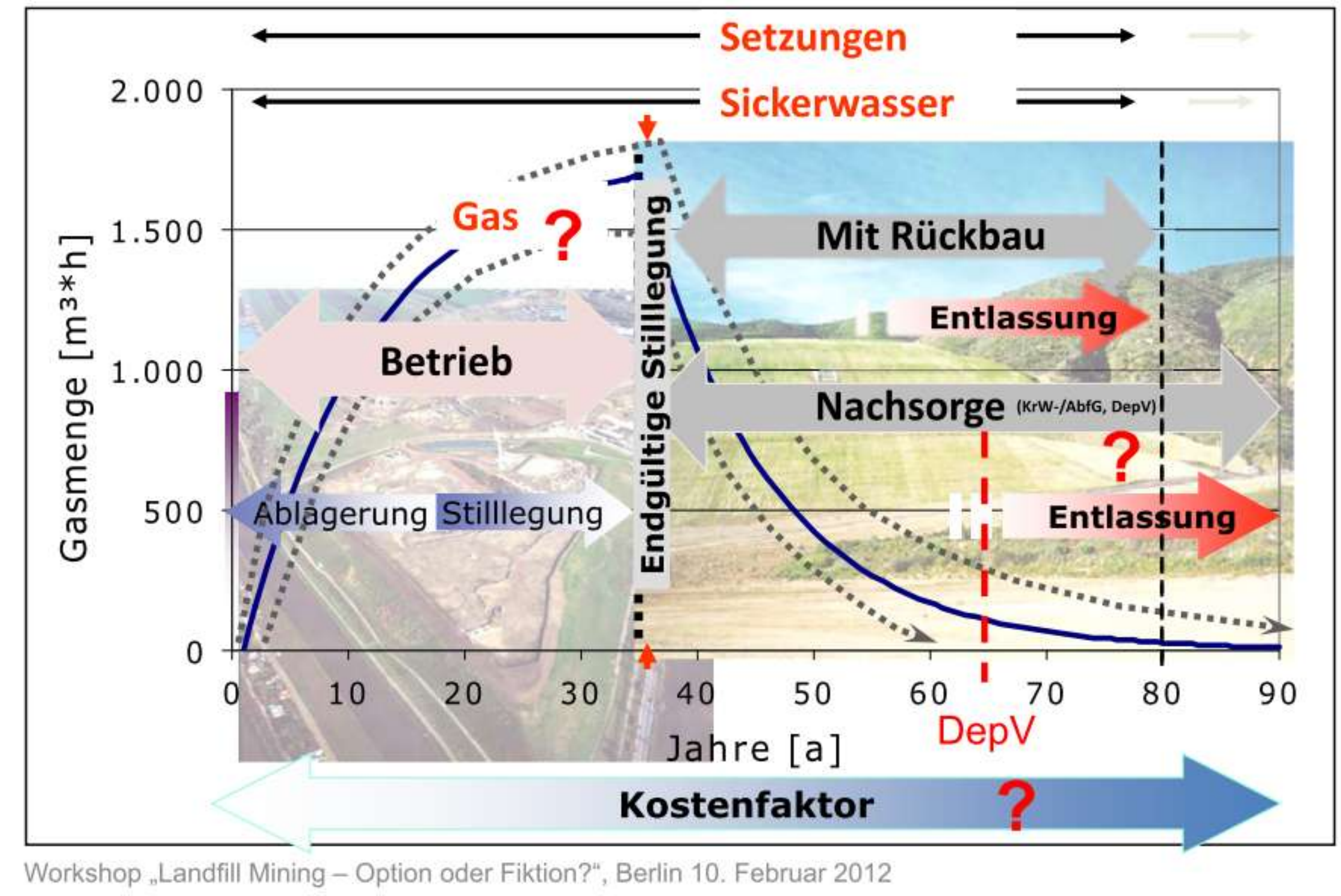
Moderný management súčasnej skládky

(source: Geosyntec Consultants 2010)

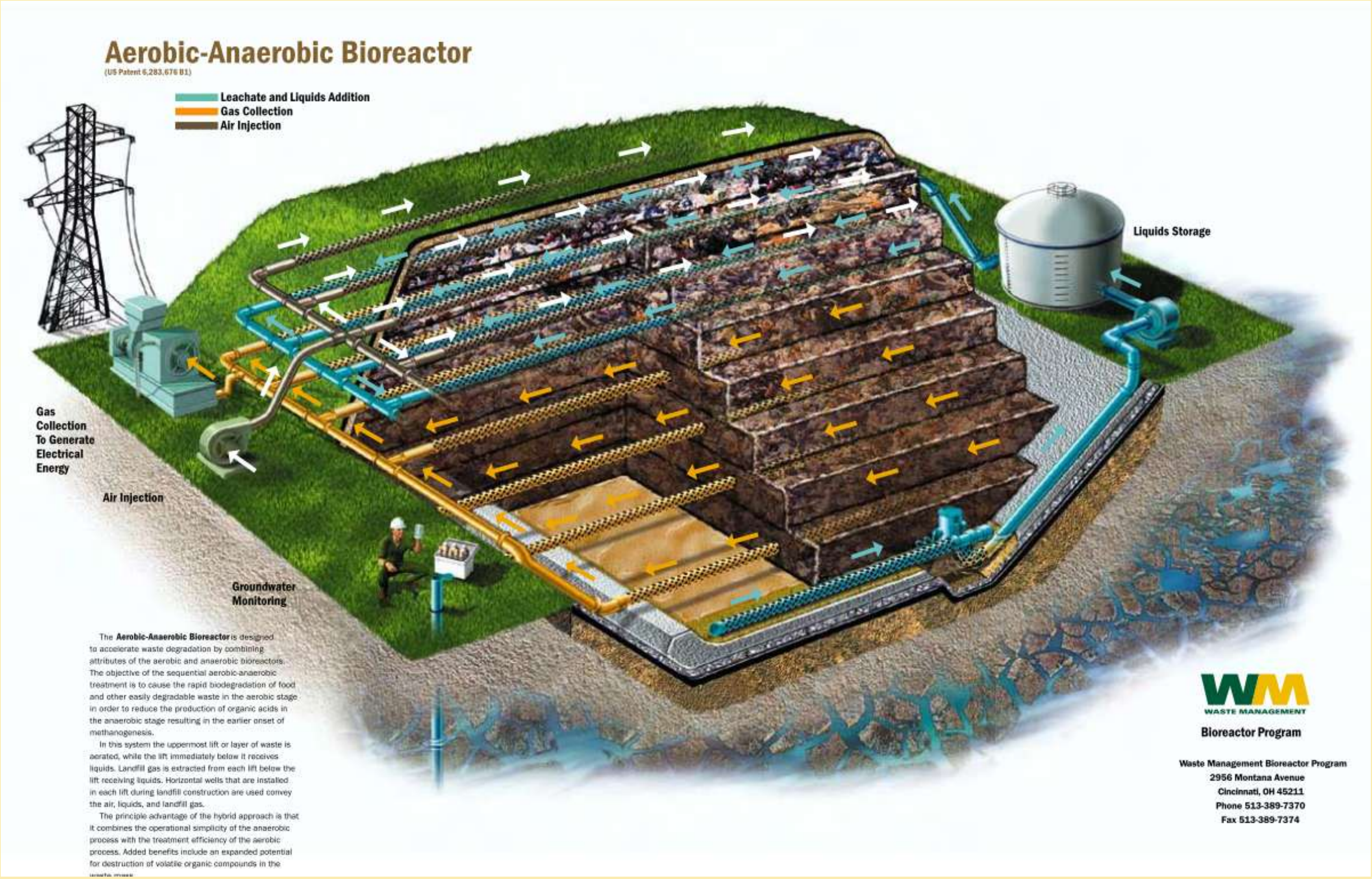


tzv. **BIOREAKTOROVÁ** skládka

Sustainable landfill .



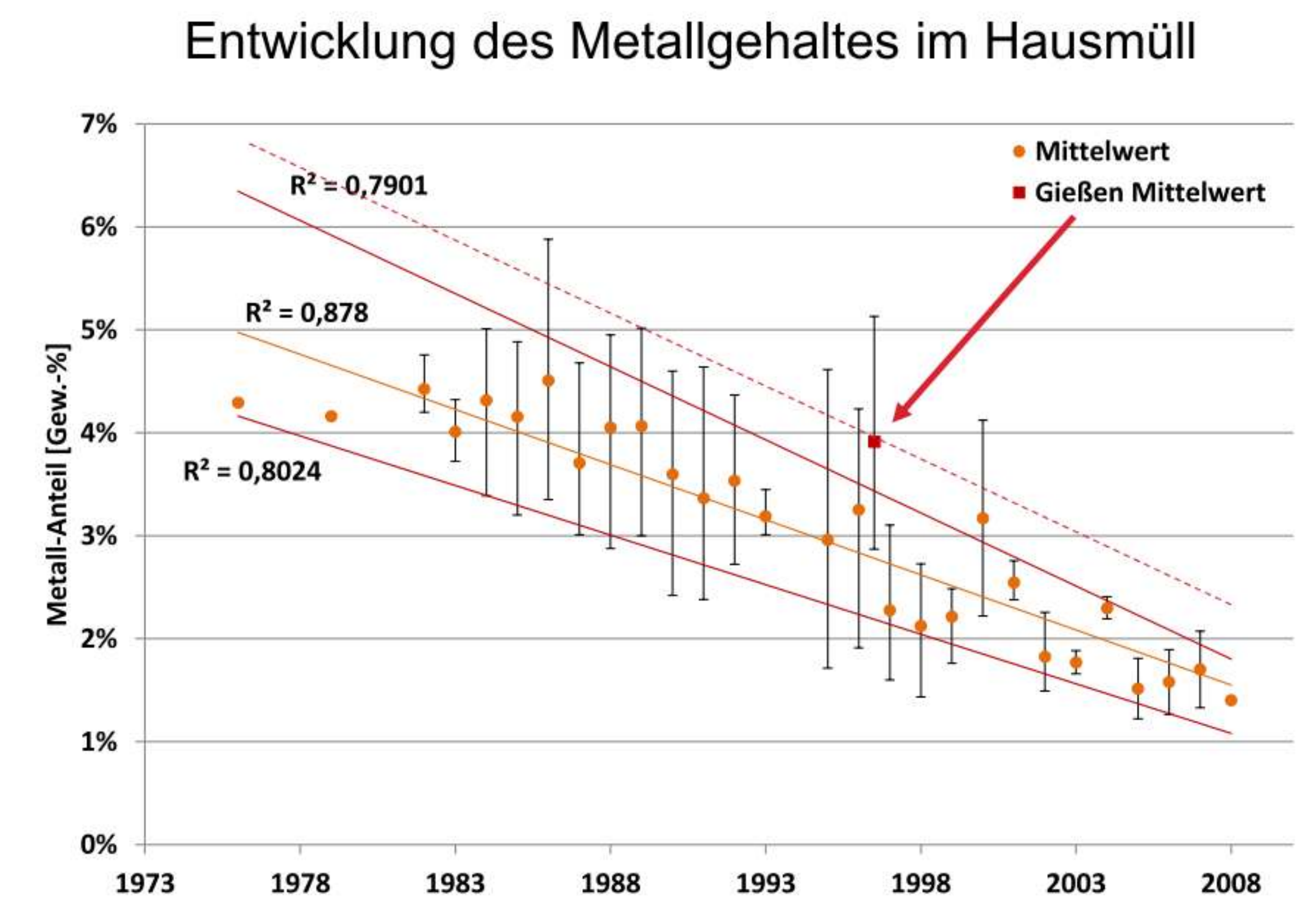
Sustainable landfill .



Budúcnosť skládkovania ?

(podľa M. Hudginsa, 2005)

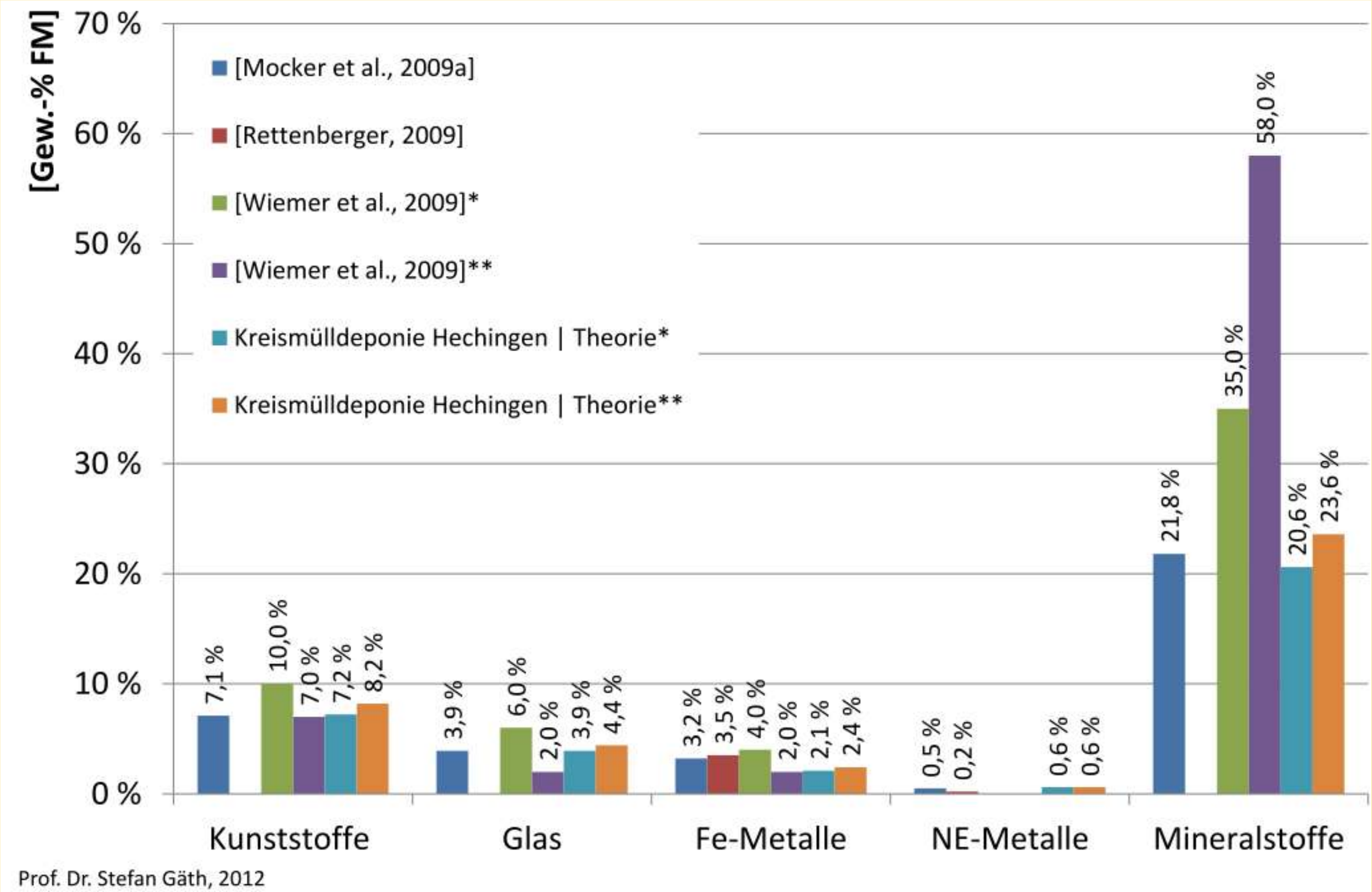
6. Suroviny v skládkach.



Prof. Dr. Stefan Gäth, 2012

- Edward Cohen-Rosenthal, JCP (2004)
  - *"a 50 acre landfill might contain as much as 240,000 tons of steel and 20,000 tons of aluminum"*
  - In total, 400 million tons of steel buried in landfills in USA
  - The concentration of valuable materials in landfills might be higher than in traditional mines

6. Suroviny v skládkach.



Landfill mining v praxi.

„Landfill mining" in Deutschland

Ort	Land
Bruchsal	B.-Württ.
Burghof	B.-Württ.
Vaihingen-Horrheim	
Eßlingen Katzenbühl	B.-Württ.
Friesenheimer Insel	B.-Württ.
Mannheim/Stadt	
Hintere Dollert	B.-Württ.
Raststatt	
Karlsruhe-West	B.-Württ.
Münchingen	B.-Württ.
Nürnberg-Süd	Bayern
Sengenbühl	Bayern
Schwaiganger	Bayern
Garmisch-Partenk.	
Schöneiche	Brandenburg
Schöneicher Plan	Brandenburg
Baunatal	Hessen
Breitenberg	Hessen
Frankfurt-Buchschlag	Hessen
Kriftel	Hessen
etc.	

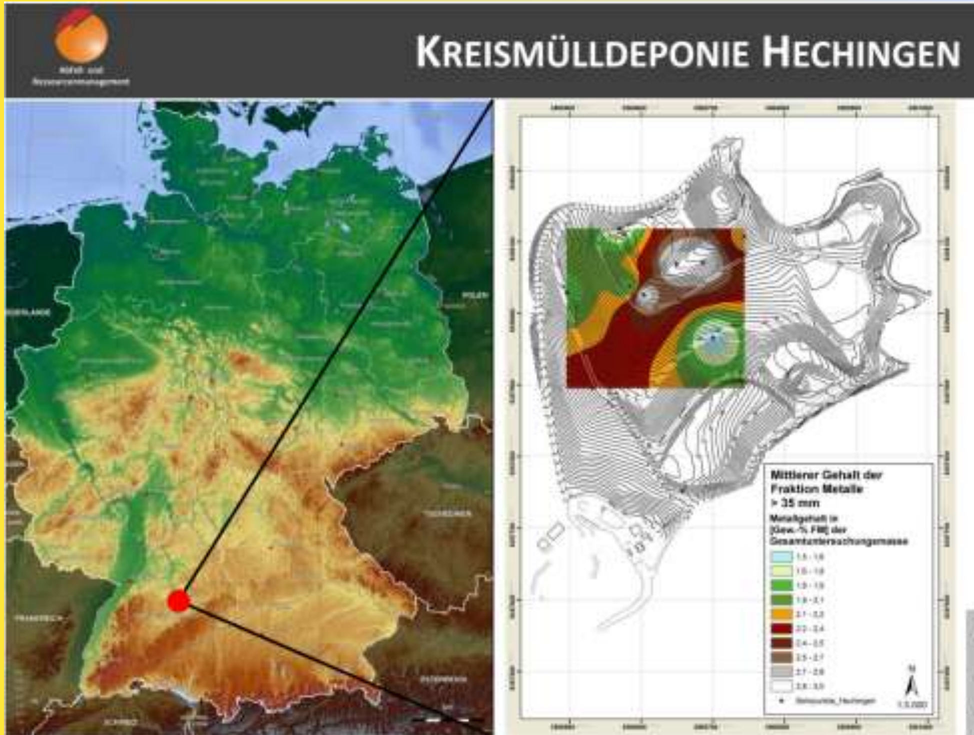
Ca. 60 bundesweite Untersuchungen bekannt!

RoadMap –
Ein Potenzialkataster für Deutschland

Kreismülldeponie Hechingen

Landfill mining v praxi.

Geo Soft Ing, s.r.o.
EKOLOGICKÉ SLUŽBY



Ablagerungsbeginn:	1964
Ablagerungssende:	1982
Ablagerungsfläche:	27,6 ha
Ablagerungsvolumen:	ca. 10,5 Mio. m^3
Abgelagerte Abfallmenge (Schätzung):	ca. 14 Mio. Mg
Deponiehöhe:	64 m (162 m üNN)
Gegenwärtiger Betriebszustand:	Stilllegungsphase

Landfill mining v praxi.

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Landfill mining at Stena Gottard's oldest landfill in Halmstad

Jakob Alm, Jonas Christéen and Gustaf Collin (2006)

- In operation 1975-1996
- Mainly shredder waste
  - Cars, white goods
- Increasing prices on metals and energy
  - Incentives for recycling
- Technology improvements
- Aim of the project
  - Could it be profitable to practice LFM on this landfill?

Landfilled amounts

Year	Amount (ton)
1975-87	250 000
1988	44 000
1989	52 000
1990	50 000
1991	41 000
1992	41 000
1993	44 427
1994	43 816
1995	45 000
1996	45 000
Total	**656 243**

- Most probable
  - Fines: 50% recycling of valuable metals
  - Waste: 70% as construction material, 20% re-landfilled and 10% disposed of as hazardous waste
- Best case
  - Fines: 75% recycling of valuable metals
  - Waste: 100% as construction material
- Worst case
  - Fines: 25% recycling of valuable metals
  - Waste: 100% disposed of as hazardous waste

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Landfill mining v praxi.

- Total profit of 400-1200 MSEK
- The project duration will be 20-25 years
  - annual profit of 16-60 MSEK
- Investments of 50 MSEK
  - The project will be profitable within 1-3 years
- Profitable as long as the metal prices do not decrease by more than 30%

Contents of the Fines

	Drilling point 1			Drilling point 2		Drilling point 3			Aver
Depth (m)	0,8-2,0	3,5-5,0	6,5-8,0	0,9-2,5	4,5-6,0	1,0-2,5	4,5-6,0	8,5-10,0	
Fe	49.4	38.5	41.9	24.1	39.7	43.9	46.3	42.2	40.8
Al	4.2	5.1	5.9	11.6	11.7	10.7	5.5	7.5	7.8
Zn	7.6	12.9	5.3	4.8	6.3	5.9	7.1	6.5	7.1
Pb	2.9	1.6	1.8	0.8	1.5	1.4	1.3	2.3	1.7
Cu	0.7	0.8	1.4	0.5	1.2	0.9	1.4	1.7	1.1
Cr	0.2	0.3	0.1	0.1	0.2	0.2	0.2	0.1	0.2
Cd	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	
Br	0.01	0.005	0.01	0.01	0.005	0.01	0.005	0.005	0.008

Landfill mining v praxi.

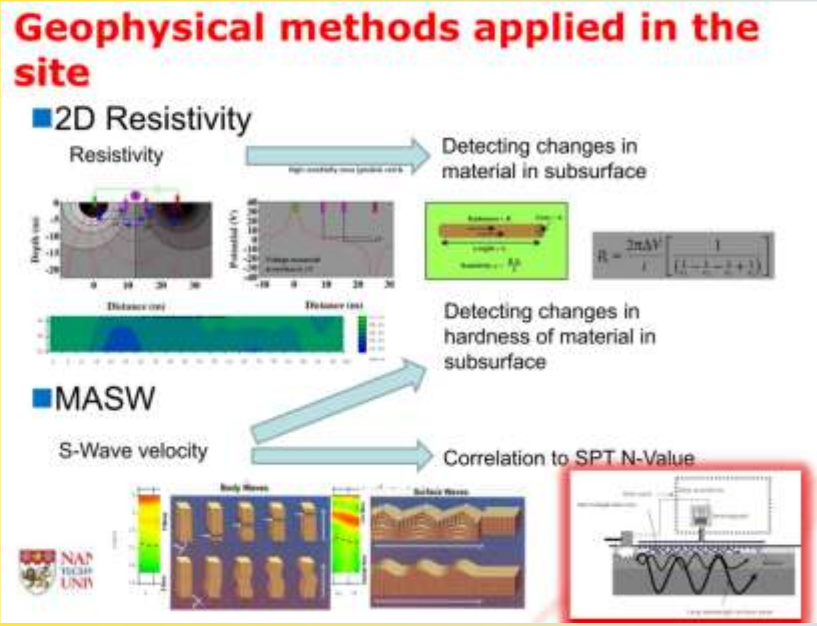
Sustainable reclamation and reuse of old dumping ground in Singapore

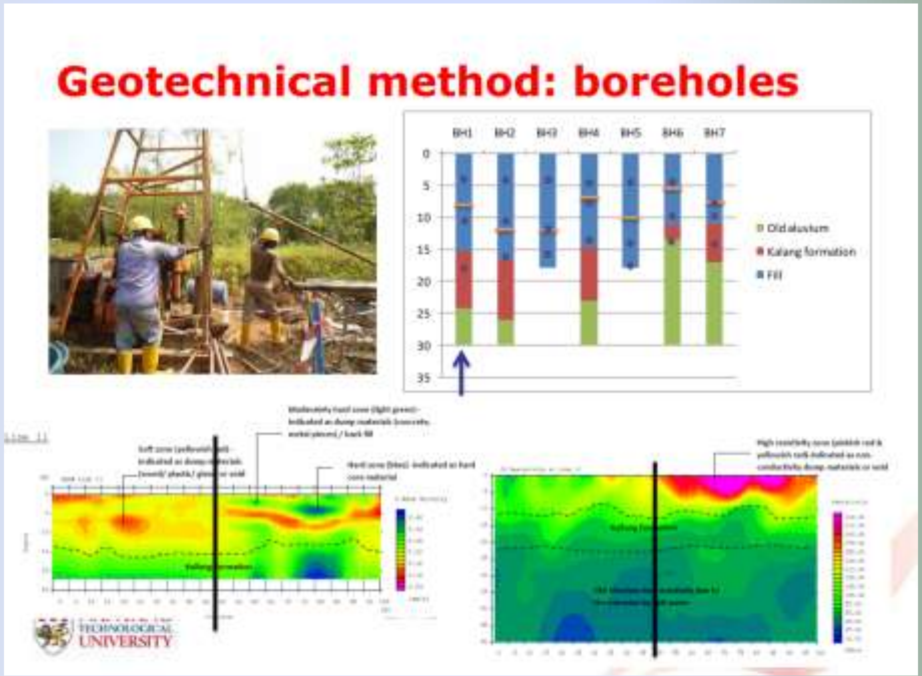
Ke Yin, Ling Xin, Charles Yonghan Chia, Huanhuan Tong and Jing-Yuan Wang
Residues and Reclamation Center (R3C)
Nanyang Technological Univesity

Background

- **Lorong Halus dumping ground is the largest closed dumping ground in Singapore**
  - LHDG ≈ 228Ha; Phase 3: 44 Ha (83-89 yr)
  - 5 reports: 1997-2005 (MontgomeryWatson, CPG and Meinhardt)
    - municipal waste + construction and demolition (C&D) waste
    - Stabilized methanogenesis phase IV (~60% CH_3)
    - Fills down to the depth of 15-20m or even 30m (e.g. phase 4)
    - leachate was detected with heavy metals (e.g. Ba, Pb), exceeded TPH (5 boreholes) from limited borehole analysis (9) and certain non methane volatile organic compounds from landfill gas (e.g. benzene)
  - Legacies: gas wells, monitoring well

Landfill mining v praxi.





Landfill mining v praxi.

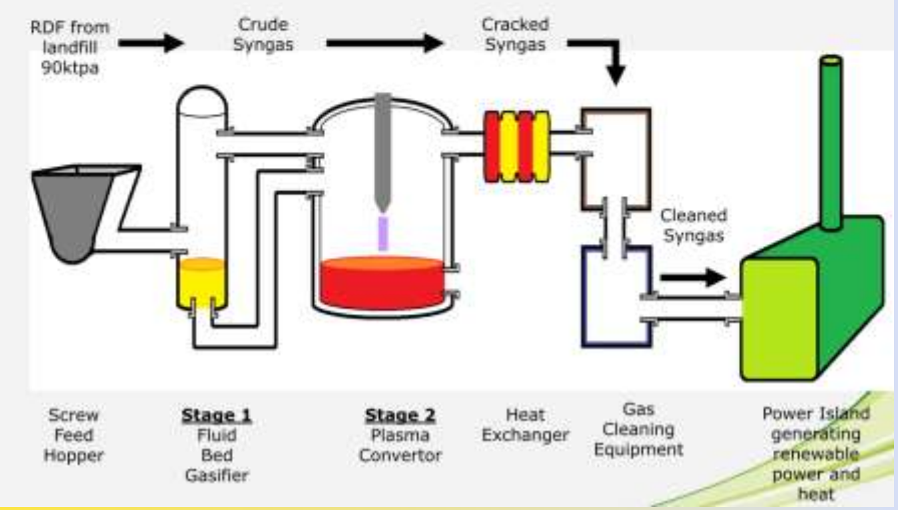
Geo Soft Ing, s.r.o.
EKOLOGICKÉ SLUŽBY

Landfill mining v praxi.

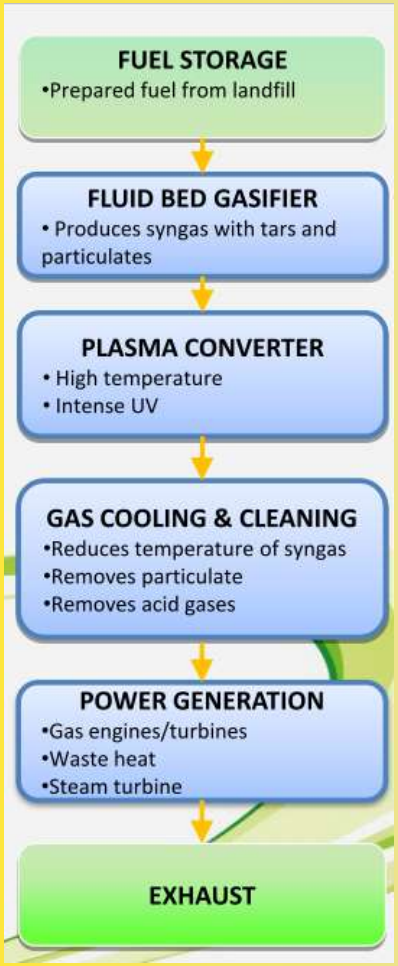
Enhanced Landfill Mining (ELFM): The Concept

- Recovery of 16 million tonnes of municipal and industrial solid waste stored at the Remo landfill site of Group Machiels in Houthalen-Helchteren/ Limburg, Belgium
- 4 Key Objectives:
  - Maximum recuperation of materials
  - Energy recovery with incorporated materials recuperation
  - CO_2 reduction, use and/or off-set
  - Recuperation of nature

The Gasplasma® Process



Landfill mining v praxi.



Gasplasma® Outputs for Phase 1 at Remo

Total landfill arising	16 million tonnes
Throughput of RDF per line*	90,000 tpa
Gross electrical output	22MWe
Net electrical output to export	18MWe
Power output	135,000 MWh pa
Power for	18,000 homes
Surplus heat for export	13 MW
Plasmarok® - product not a waste	14,000 tpa
Exceptionally low residual wastes	2,000 t APC pa
Bottom ash	Nil
Emissions	IED/ Vlarem II compliant

Ďakujem za pozornosť

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