

# How WEEE recycling can improve access to critical raw materials

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**Going Green**  
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# Two ways of raw materials supply

- “ore grade” in some e-scrap fractions by factor 50 higher

Primary production @  $\approx 5$  g/t Au in ore  
Similar for PGMs



Recycling: 200-250 g/t Au in PC circuit boards  
300-350 g/t Au in cell phones,



# The EU Raw Materials Initiative (RMI)

Raw materials - Enterprise and Industry - Microsoft Internet Explorer provided by Umicore

Adresse: [http://ec.europa.eu/enterprise/policies/raw-materials/index\\_en.htm](http://ec.europa.eu/enterprise/policies/raw-materials/index_en.htm)

European Commission > Enterprise and Industry > Policies > Raw materials

**Enterprise and Industry**

- Policy highlights
- Industry sectors
- Reference documents
- Useful links
- Questions and terms
  - Acronyms
  - Glossary
  - Questions and answers
- Enterprise e-Services portal
- Multimedia portal

**Non-energy raw materials**

Non-energy raw materials are an essential part of both high tech products and every-day consumer products, such as houses, automobiles, computers, and mobile phones. European industry needs fair access to raw materials both from within and outside the EU. On the one hand, exploration and extraction are facing increased competition for different land uses and a highly regulated environment. On the other hand, the EU is highly dependent on imports of economically important raw materials which are increasingly affected by market distortions.

More... Show / Hide

International aspects

Sustainable supply in the EU

Resource efficiency and recycling

Critical raw materials

Facts and figures

Communication (2008) 699: "The raw materials initiative – meeting our critical needs for growth and jobs in Europe", Staff Working Document SEC (2008) 2741

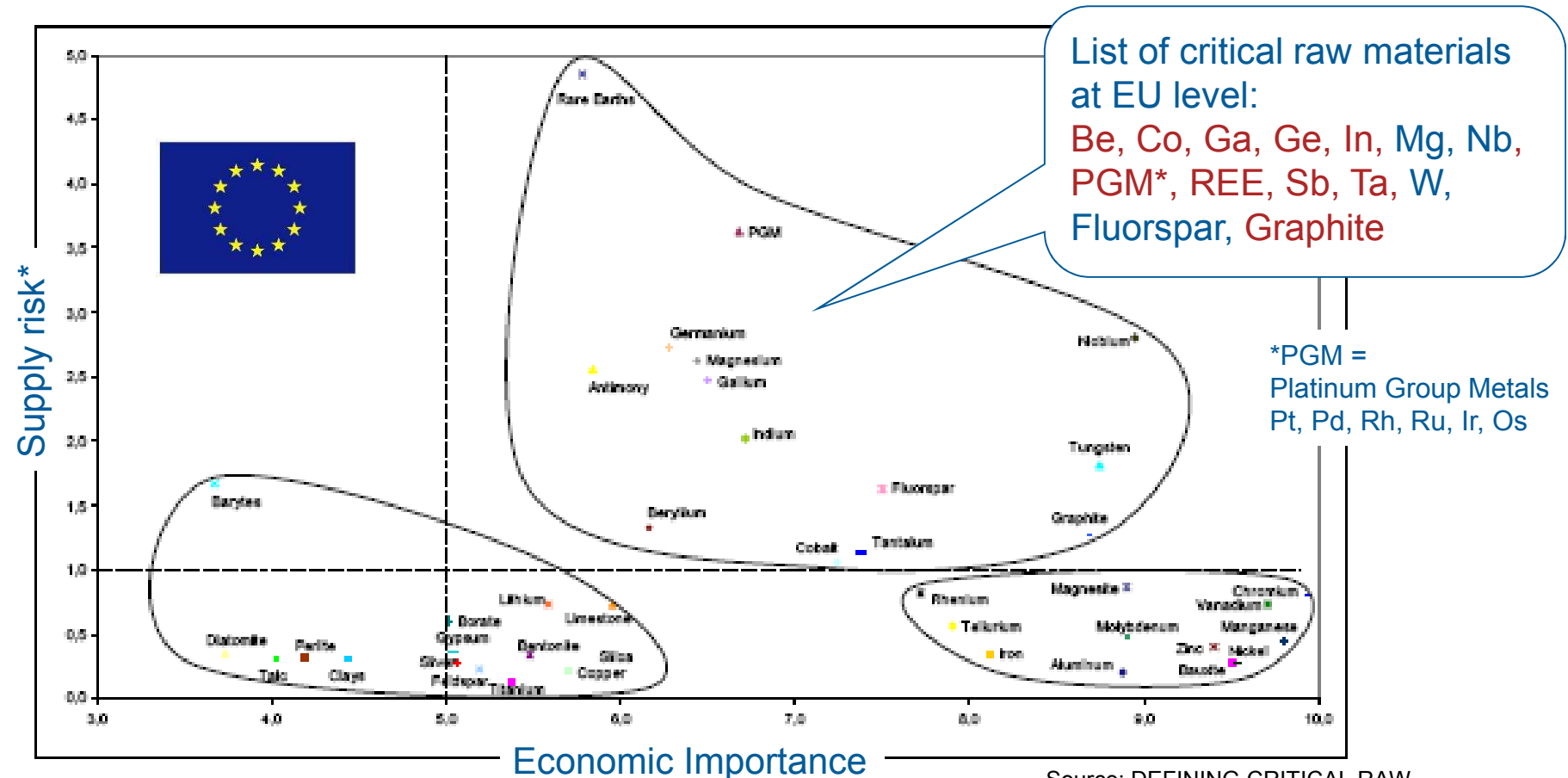
1. *Ensure access to raw materials ... etc*
2. *Set the right framework conditions ... etc*
3. **Boost overall resource efficiency and promote recycling to reduce the EU's consumption of primary raw materials and decrease the relative import.**





# EU RMI - 14 raw materials identified as critical

– most of them needed for EEE



\* depending on: level of concentration of ww production (HHI) linked with World Bank “ww governance indicator” + potential for substitution + current recycling rate

Source: DEFINING CRITICAL RAW MATERIALS FOR THE EU: A Report from the Raw Materials Supply Group ad hoc working group defining critical raw materials; July 30, 2010

# Metal use in electronics – volume counts

## Global sales, 2008 (2009):

### a) Mobile phones:



1300 Million units

x 250 mg Ag  $\approx$  325 t Ag

x 24 mg Au  $\approx$  31 t Au

x 9 mg Pd  $\approx$  12 t Pd

x 9 g Cu  $\approx$  12,000 t Cu

1300 M batteries\*

x 3.8 g Co  $\approx$  4900 t Co

\* Li-Ion type

### b) PC & laptops:



300 Million units

x 1000 mg Ag  $\approx$  300 t Ag

x 220 mg Au  $\approx$  66 t Au

x 80 mg Pd  $\approx$  24 t Pd

x  $\approx$  500 g Cu  $\approx$  150,000 t Cu

$\approx$ 140 M laptop batteries\*

x 65 g Co  $\approx$  9100 t Co

\*\* Li-Ion type

### World mine / a+b production / share

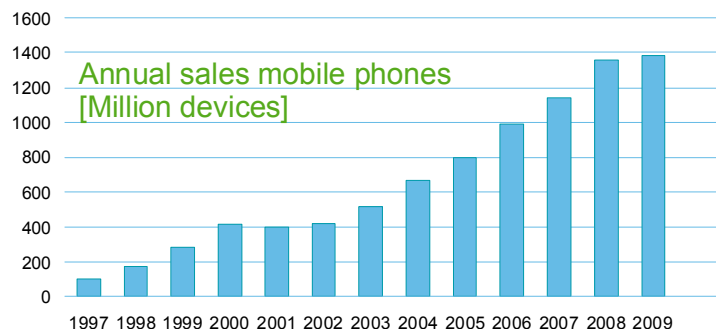
Ag: 21,000 t/a  $\blacktriangleright$  3%

Au: 2,400 t/a  $\blacktriangleright$  4%

Pd: 220 t/a  $\blacktriangleright$  16%

Cu: 16 Mt/a  $\blacktriangleright$  <1%

Co: 75,000 t/a  $\blacktriangleright$  19%



Cumulated sales of mobile phones:

8.6 billion devices with 2100 t Ag, 200 t Au, 80 t Pd

Precious metal value at June 2010 prices  $\approx$  8,5 billion €

How much of this will finally be recycled ?

# The challenge: The good, the bad and the ugly

- recovering valuables while taking care of hazards



## E-scrap, a complex mix ...

- Ag, Au, Pd... (precious metals)
- Cu, Al, Ni, Sn, Zn, Fe, Bi, Sb, In... (base- & special metals)
- Hg, Be, Pb, Cd, As, ... (substances of concern)
- Halogens (Br, F, Cl...)
- Plastics & other organics
- Glass, ceramics

# Composition of mobile phones

mobile phone substance (source Nokia)

1	2																	18	19
1	H																	2	He
2	Li	Be															10	Ne	
3	Na	Mg															18	Ar	
4	K	Ca	Sc	Ti	V	Cr	Mn	Fe	Co	Ni	Cu	Zn	Ga	Ge	As	Se	Br	Kr	
5	Rb	Sr	Y	Zr	Nb	Mo	Tc	Ru	Rh	Pd	Ag	Cd	In	Sn	Sb	Te	I	Xe	
6	Cs	Ba	La-Lu	Hf	Ta	W	Re	Os	Ir	Pt	Au	Hg	Tl	Pb	Bi	Po	At	Rn	
7	Fr	Ra	Ac-Lr	Rf	Db	Sg	Bh	Hs	Mt	Uuo	Uub	Uut	Uuq	Uup	Uuh	Uus	Uu		

- ⇒ Environmental risk in case of landfill & inappropriate recycling
- ⇒ Valuable metal resource



## EEE - huge impact on metal demand

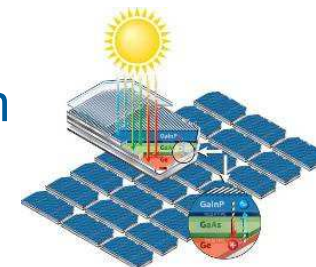
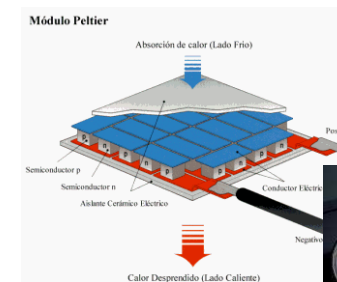
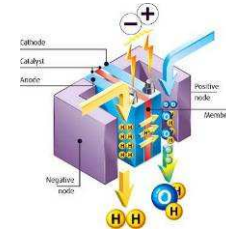
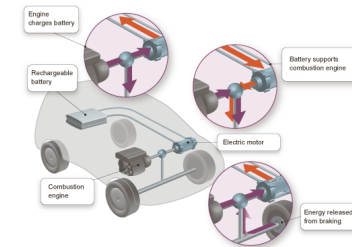
	% used in EEE*	Main application(s)	By-product from
• Indium:	80%	LCD glass	Zn, Pb
• Ruthenium:	> 80%	hard disks	PGM
• Antimony:	~ 50%	flame retardants	(Cu, Pb, Zn)
• Tin:	~ 35%	solder	
• Copper:	30%	cables, wires, e-motors	
• Silver:	30%	contacts, solder, MLCC	(Pb, Zn)
• Cobalt:	20%	rechargeable batteries	(Ni, Cu)
• Selenium:	~ 20%	electro-optics	Cu
• Palladium:	~ 15%	MLCC, connectors	PGM
• Gold	~ 10%	bonding wire, contacts, IC	(Cu)

\* rounded based on 2007 sales

# Emerging technologies further increase pressure on demand for technology metals

## Examples:

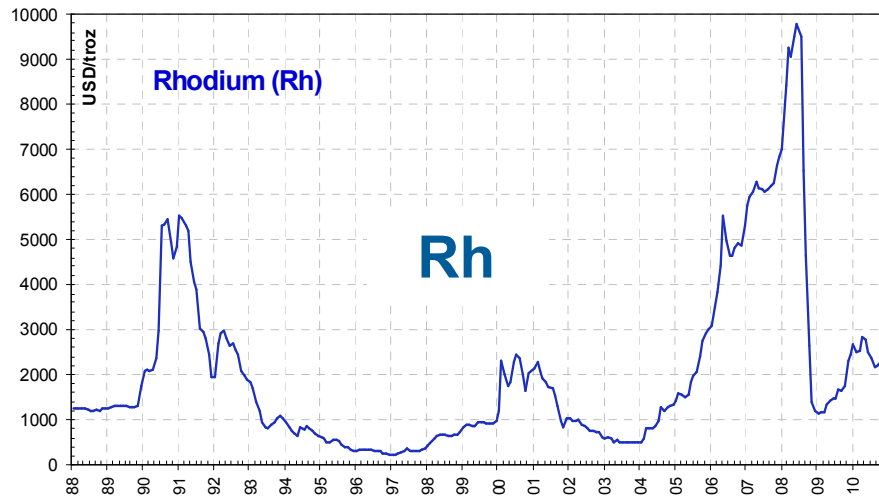
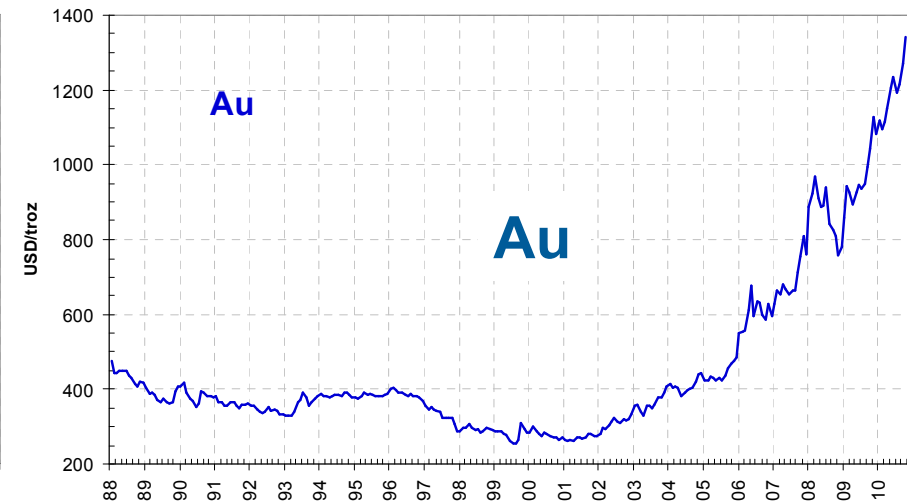
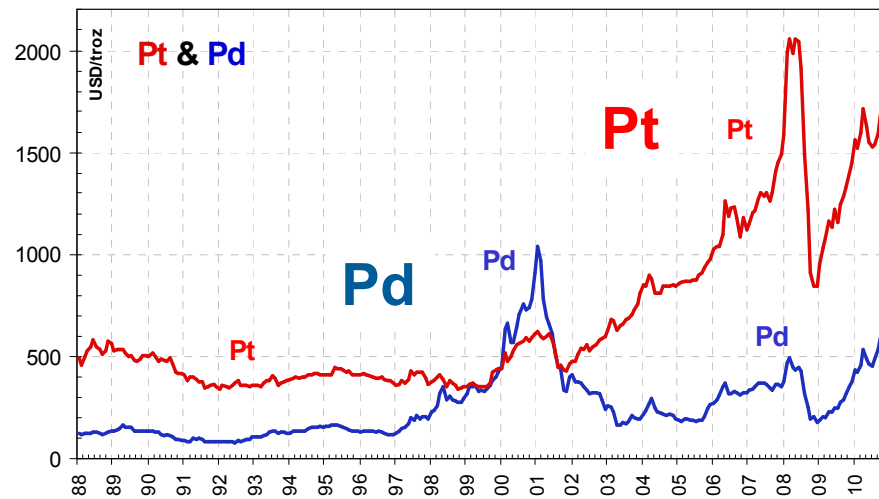
- **Electric vehicles & batteries:**  
cobalt, lithium, rare earth elements, copper
- **Fuel cells:**  
platinum, (ruthenium, palladium, gold)
- **Thermo-electrics, opto-electronics, LEDs, ...:**  
bismuth, tellurium, silicon, indium, gallium, arsenic, selenium, germanium, antimony, ...
- **Photovoltaic (solar cells):**  
silicon, silver, indium, gallium, selenium, germanium





# Precious Metal prices 1988-2010/10

## – just short impact of economic crisis





## Recycling recommendations developed by the RMI critical metals group



### Undertake policy actions to make recycling of critical raw materials more efficient, in particular by:

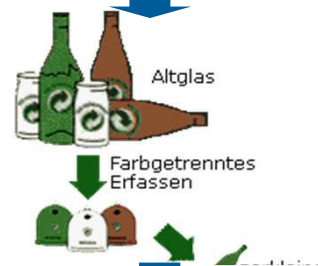
- Mobilising relevant EoL products for **proper collection** instead of stocking, landfill or incineration
- Improving overall **organisation, logistics & efficiency of recycling chains** by focussing on interfaces and system approach
- Preventing **illegal exports** of relevant EoL products & increasing **transparency** in flows
- Promoting **research on system optimisation & recycling** of technically challenging products & substances

Source: DEFINING CRITICAL RAW MATERIALS FOR THE EU: A Report from the Raw Materials Supply Group ad hoc working group defining critical raw materials; July 30, 2010 [http://ec.europa.eu/enterprise/policies/raw-materials/critical/index\\_en.htm](http://ec.europa.eu/enterprise/policies/raw-materials/critical/index_en.htm)

# How to recycle: spot the difference

## - Mass materials recycling doesn't fit for technology metals

### Bottle glass:

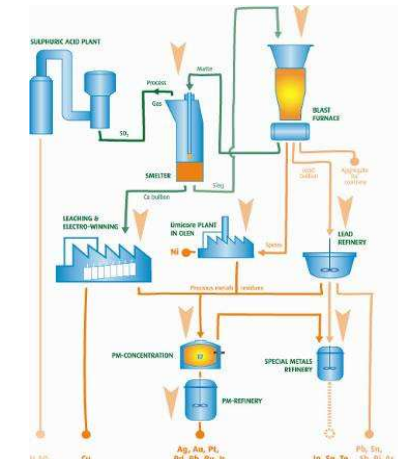
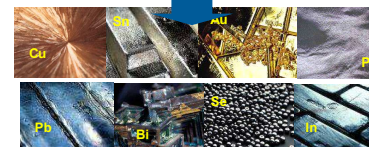
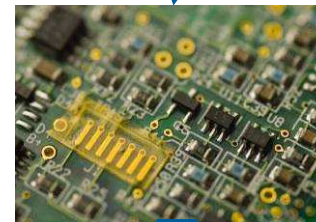
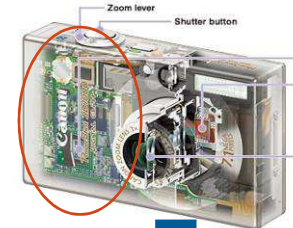


- Green glass
- white glass
- brown glass

### Steel scrap:



### circuit boards or mobile phones:



High-tech metallurgical refining processes needed

- “**mono-substance**” materials without hazards
- trace elements remain part of alloys/glass
- Recycling focus on mass and costs

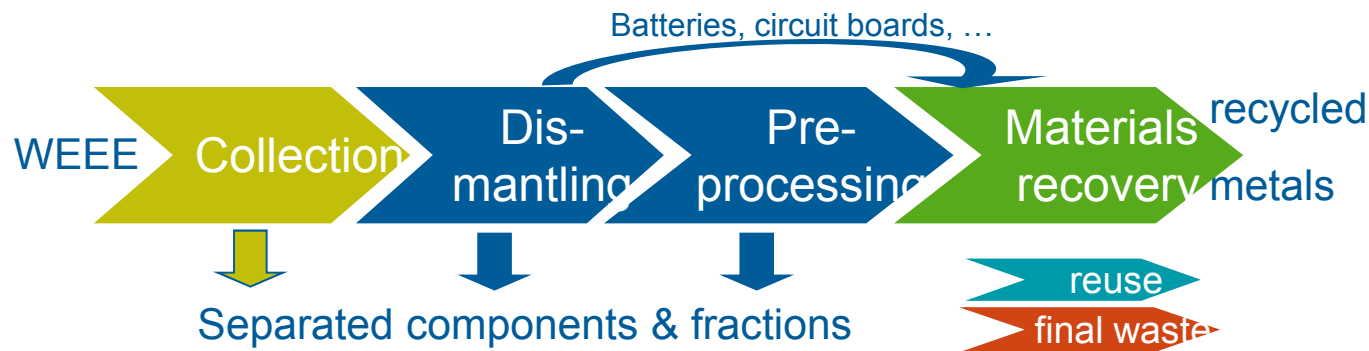
- “**poly-substance**” materials, incl. hazardous elements
- complex components as part of complex products
- recycling focus on value recovery from trace element



# Recycling chain

- system approach is key for technology metals

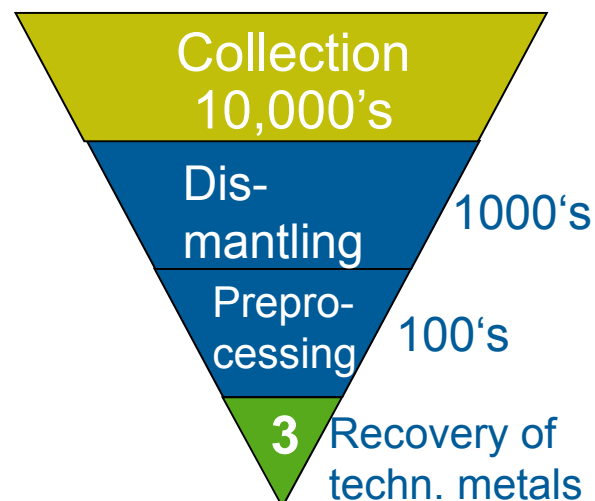
Example: 50% x 90% x 80% x 95% = 34%



- Consider entire chain & its interdependences
- Mass flows  $\neq$  flows of technology metals
- interface optimisation, economies of scale, specialisation

**Total efficiency determined by weakest step in the chain**

Number of actors in Europe

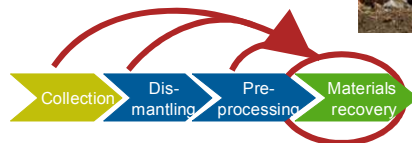


- Significant downstream increase of Investments & technology requirements
- Sufficient capacity for recovery of technology metals available
- Make sure that critical fractions reach these plants!

# Main flaws in EU WEEE recycling



## a) Poor collection



## b) Deviation of collected materials ⇒ dubious exports ⇒ backyard treatment



fotos: Okopoi



foto: EMPA/CH

# Losses are losses, no matter where they occur

- significant potential for system optimisation



„There“



**Au recycling  
efficiency\*:**

**80 %  
Collection**

**x 50 %**

**dismantling/pre-processing**

**x 50 % = 20 %\***

**metals recovery**