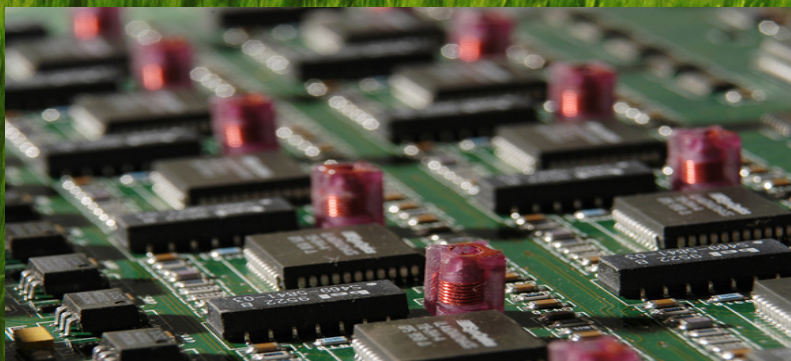


Global Best Practices & Technologies for E-waste Recycling

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Umicore Precious Metals Refining

Cairo, February 9-10, 2009





- **Benefits of Environmentally Sound Management (ESM) for e-waste**
- **Recycling in Practice**
- **Reuse: PROs & CONs**
- **Challenges & Opportunities for North Africa**

■ 'Benefits of Environmentally Sound Management (ESM) for e-waste

- ✓ Solving a fast growing waste stream
- ✓ Reducing a threatening resource scarcity
- ✓ Toxic control
- ✓ CO₂ efficiency
- ✓ Closed Loop recycling
- ✓ Economically viable



ESM: Solving a fast growing waste stream



2007 global sales

- Cell phones: 1200 M units
→ 200 000 ton
- PC, Laptop: 255 M units
→ 2 500 000 ton

SALE ↗

LIFETIME ↘

Sales growth rate

- Cell phones: 15 %
- Laptops: 28 %



ESM: Reducing a threatening resource scarcity



Electronics have a significant impact on metals demand

- Small metal content x large unit sales = significant mass !
- Metal value: **4.1 billion US-\$**
- Rising and prices (span of last years): imbalance in supply and demand
- Final recycling rate ?

a) Cell phones:



1200 Million units

x 250 mg Ag ≈ 300 t Ag
 x 24 mg Au ≈ 29 t Au
 x 9 mg Pd ≈ 11 t Pd
 x 9 g Cu ≈ 11,000 t Cu

1200 M x 20 g/battery*

x 3.8 g Co ≈ 4500 t Co

* Li-Ion type

b) PC & laptops:



255 M units

x 1000 mg Ag ≈ 255 t Ag
 x 220 mg Au ≈ 56 t Au
 x 80 mg Pd ≈ 20 t Pd
 x ≈ 500 g Cu ≈ 128,000 t Cu

≈100 M laptop batteries*

x 65 g Co ≈ 6500 t Co

** Li-Ion type is > 90% used in modern laptops

World Mine / a+b Production / share

Ag: 20,000 t/a ▶ 3%

Au: 2,500 t/a ▶ 3%

Pd: 230 t/a ▶ 13%

Cu: 16 Mt/a ▶ 1%

Co: 60,000 t/a ▶ 15%

ESM: Toxic control

⇒ most toxics & most valuable metals are contained in the circuit boards

- ◆ Ag, Au, Pd, ... (precious metals)
- ◆ Cu, Al, Ni, Sn, Zn, Fe, ... (base metals)
- ◆ Hg, Be, Pb, Cd, As, Sb, Bi, ... (metals of concern!)
- ◆ Halogens (Br, F, Cl, ...)
- ◆ combustibles (plastics)

⇒ high risk of environmental damage if landfilled or if not treated in an environmentally sound way

'ESM' provides a high resource recovery & takes care of toxics

Valuable resource or toxic substance ?

Example Pb out of WEEE:

ESM

Recovery of Pb, i.e. for car batteries

(price Pb ~ 910 €/t in Feb '09)



NO ESM

high Pb emissions into groundwater, soil and air

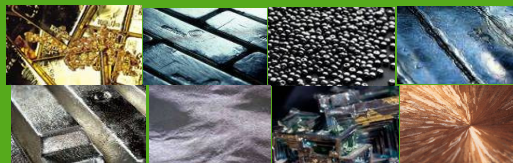


Foto BAN

Example printed circuit boards:

ESM

High net metal value (~ 3500 €/t).
Source of Ag, Au, Pd, Cu, Pb, Sn, Bi, Sb,...



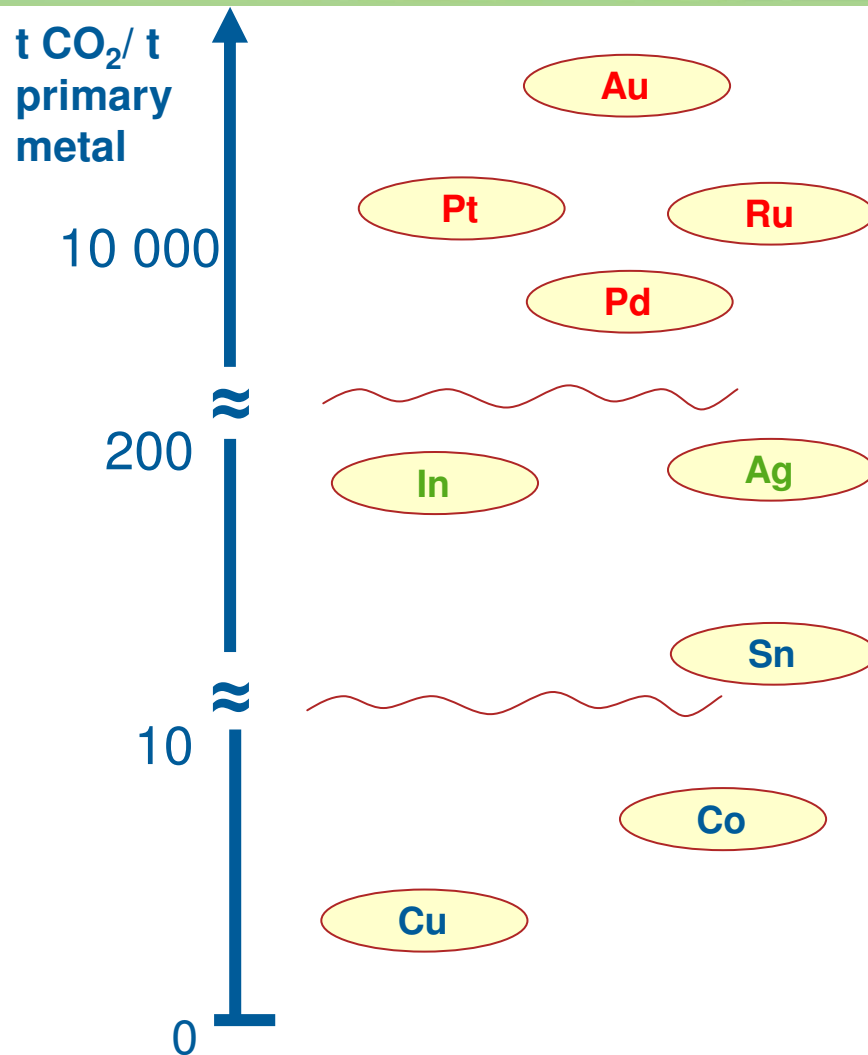
NO ESM

Significant emissions of dioxins, heavy metals & other toxic substances



ESM: CO₂ efficiency

Environmental impact of metal production - CO₂



Environmental impact:

- CO₂ emissions: 23.4 Mt/y for all EEE (primary production)
- additional impacts from SO₂, land use, waste-water, etc.
- Impact of recycling/remelting much less

ESM: Reducing CO₂ emission significantly

Example:

Umicore Precious Metals Refining, Hoboken/Belgium (UPMR):

- recovered metals 2007*: 70,000 t
- total CO₂ impact of UPMR in 2007*: 0.27 Mt 
- total CO₂ impact primary production**: 1.3 Mt 
- ▶ CO₂ saving potential recycling*: 1.0 Mt 

*from treatment of 300,000 t of recyclables & smelter by-products.

Output: 1000 t Ag, 30 t Au, 37 t PGM, 65 000 t Cu/Pb/Ni, 3500 t Sn/Se/Te/In/Sb/Bi/As

**if these metals would have come from primary production, calculated with ecoinvent 2.0:

the unavoidable “black box approach” of the UPMR calculation mixes the CO₂ impacts of very low grade materials (e.g. slags, flue dusts) with richer ones from recycling of consumer goods (e.g. circuit boards, catalysts)

▶ for recycling of electronics the CO₂ benefit compared to mining is even higher!



■ Recycling in Practice

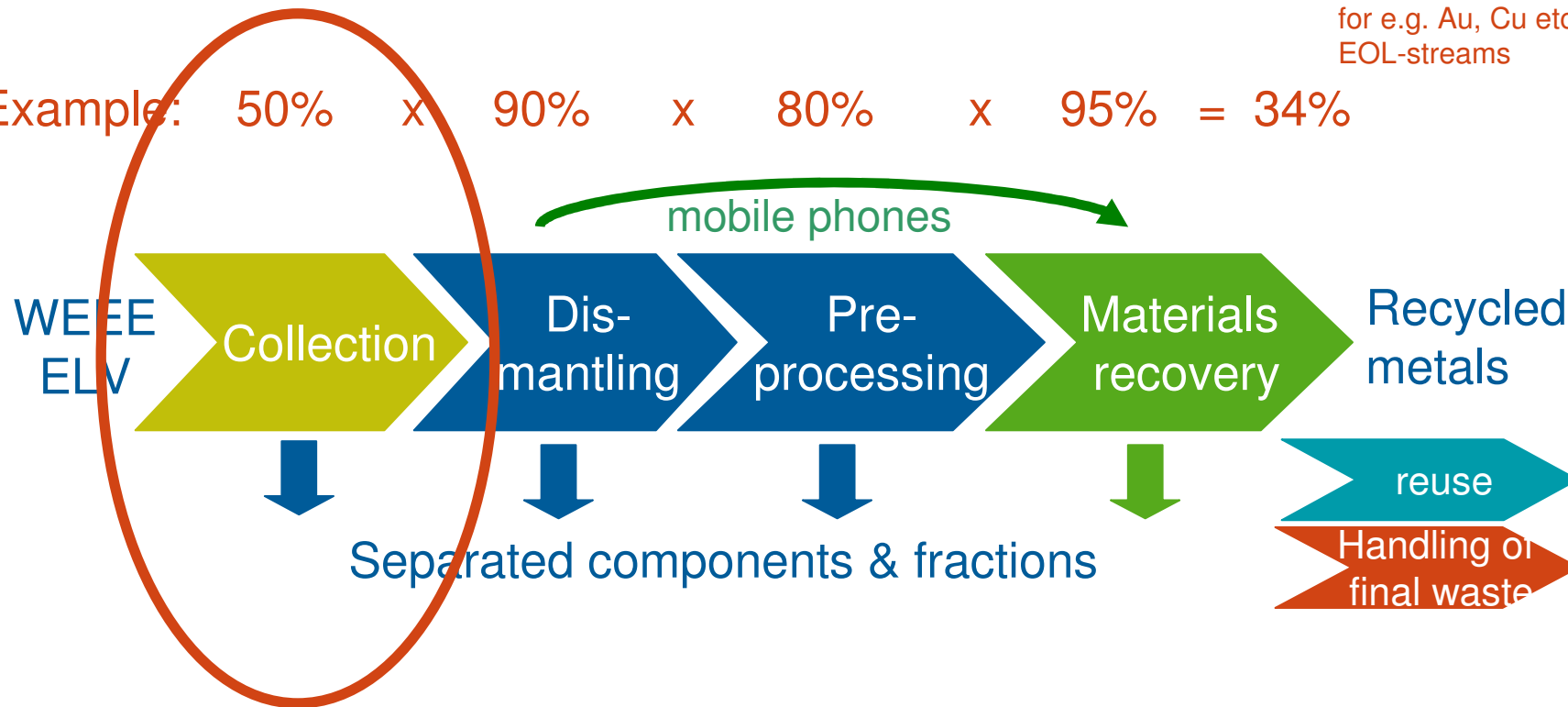
✓ Recycling chain

✓ Umicore's 'ESM' technology

Recycling chain

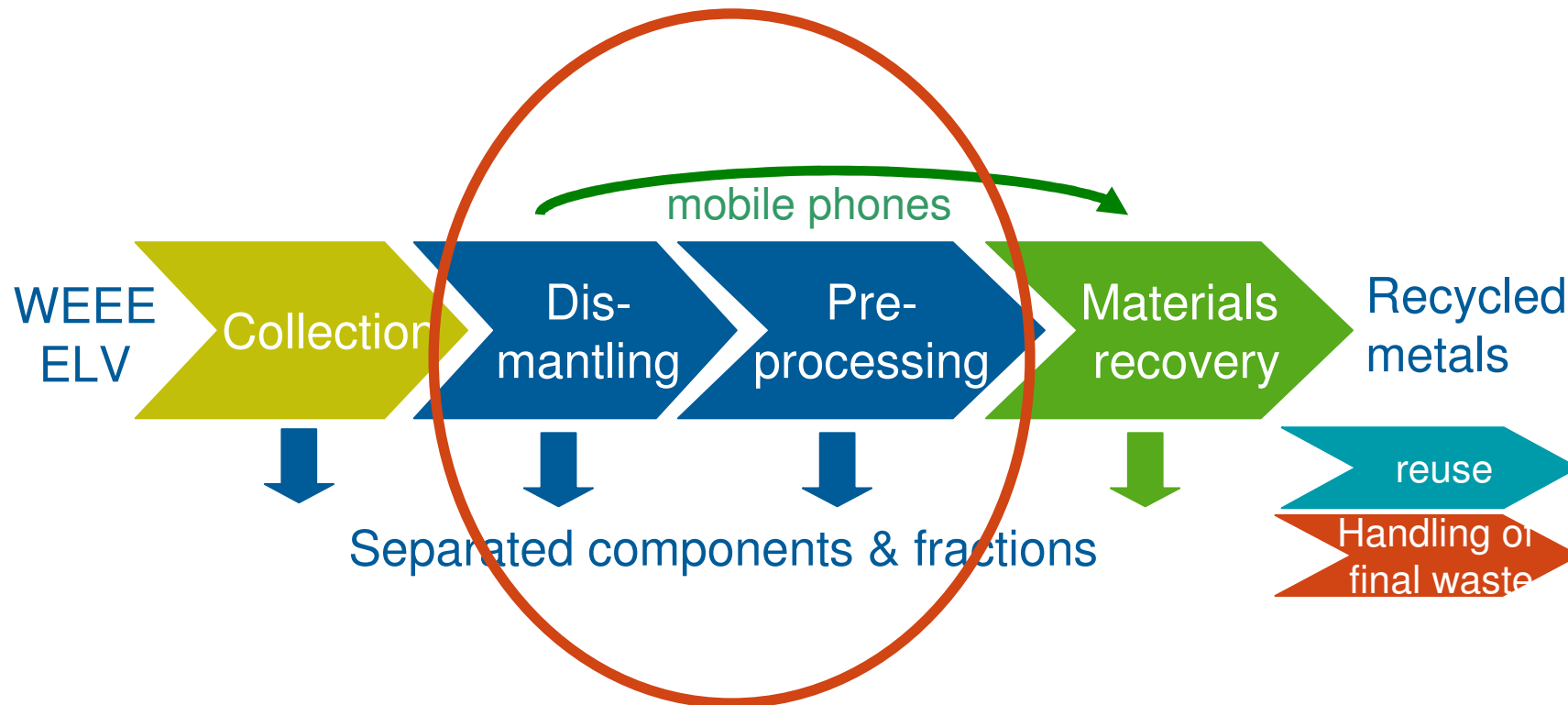
*effective recovery rate
for e.g. Au, Cu etc. from
EOL-streams

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



- **Total efficiency is determined by the weakest step**
Consider the entire chain & its interdependencies

Recycling chain



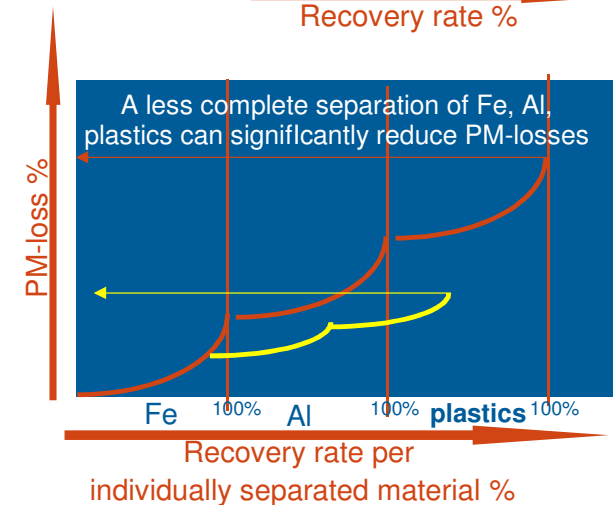
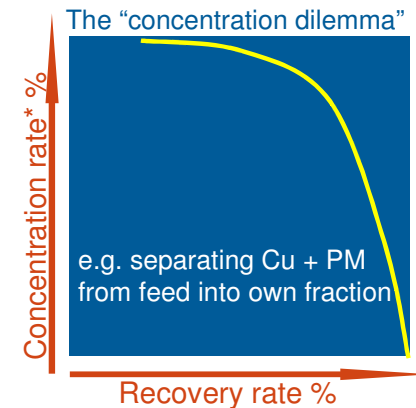
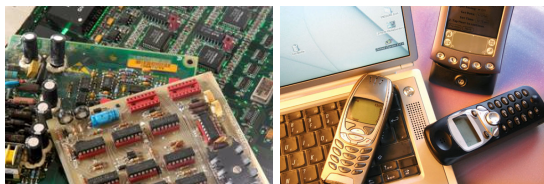
Mechanical processes

require good liberation of substances to be separated
→ dismantling, shredding/crushing

Sorting by physical properties:
magnetic, eddy current, density separation,
supported by screening/sizing, further crushing

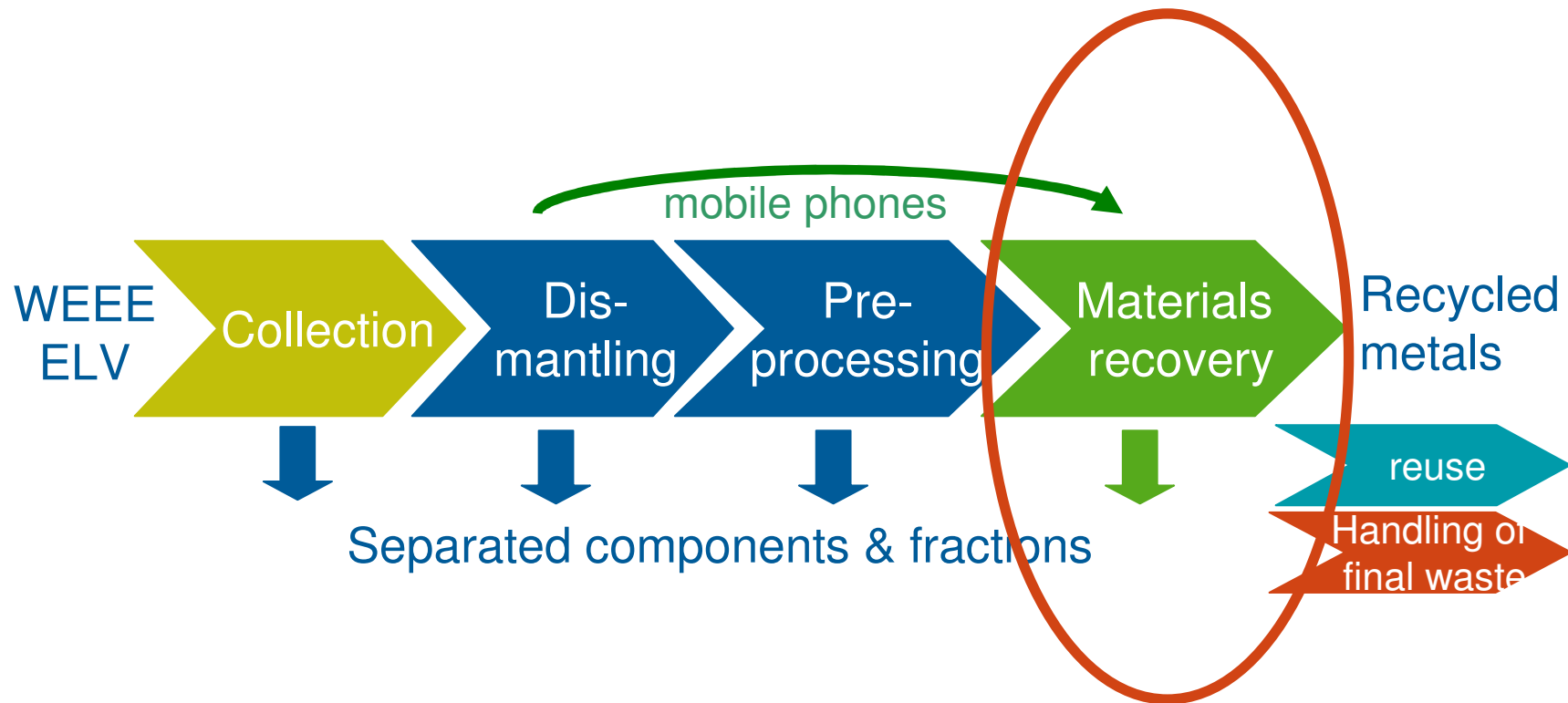
Limitations:

- Selectivity (overlap between physical properties)
- Handling of dust and fines
- Conflict concentration ↔ yield (“concentration dilemma”)
- Unintended co-separation of minor metals (PM)



→ **The more complex/interlinked the material, the less selective are mechanical processes and the higher are losses by co-separation**

Recycling chain



Metals recovery: Umicore's BAT technology



Umicore's integrated metals smelter at Hoboken/Antwerp

Au yield > 95%

- Innovative technology, focus on secondary PM materials
- Recovering 17 metals: Au, Ag, Pd, Pt, Rh, Ir, Ru, Cu, Pb, Ni, Sn, Bi, Se, Te, Sb, As, In

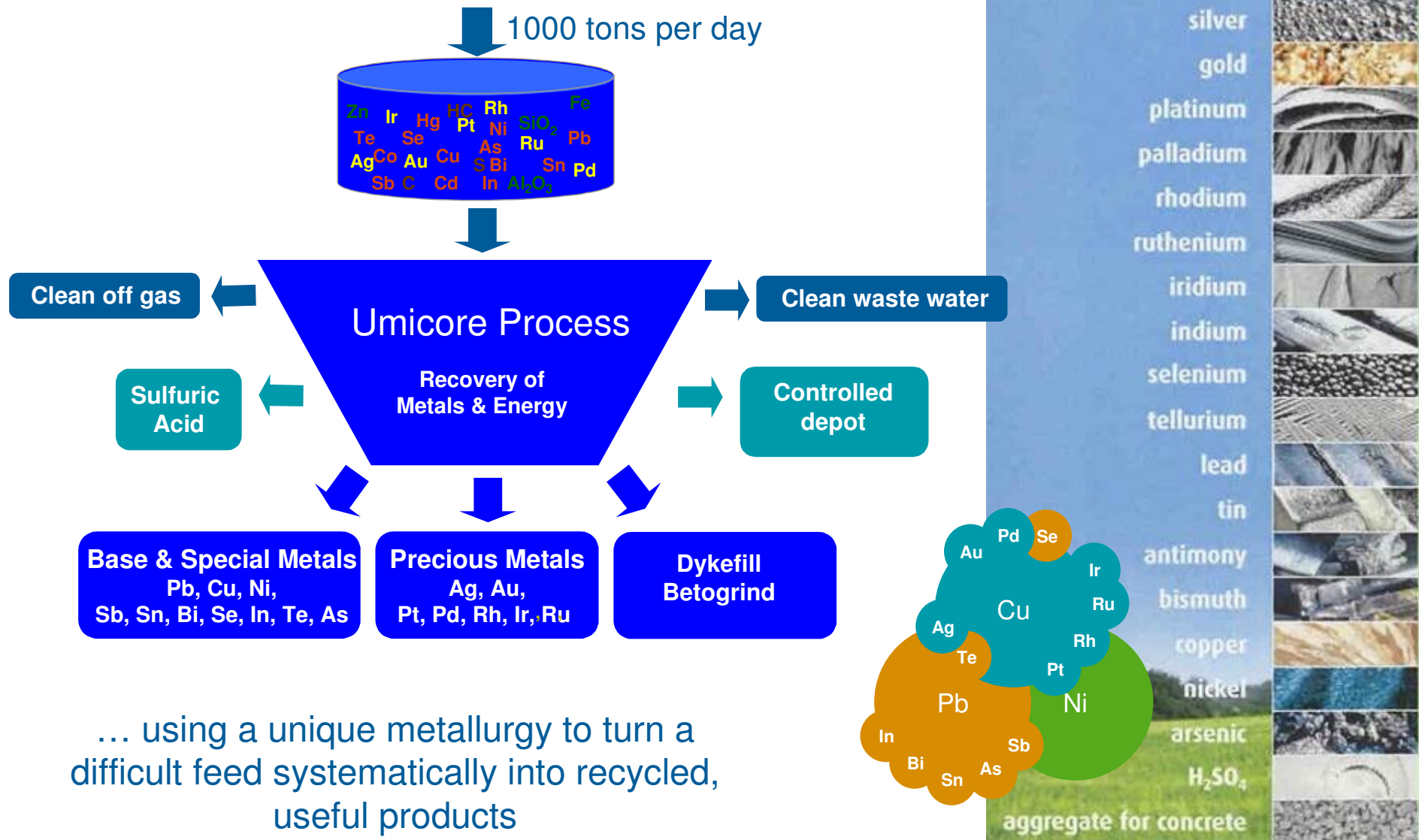
recovered metal value

(2007):

PM: 2600 M\$, others 400 M\$

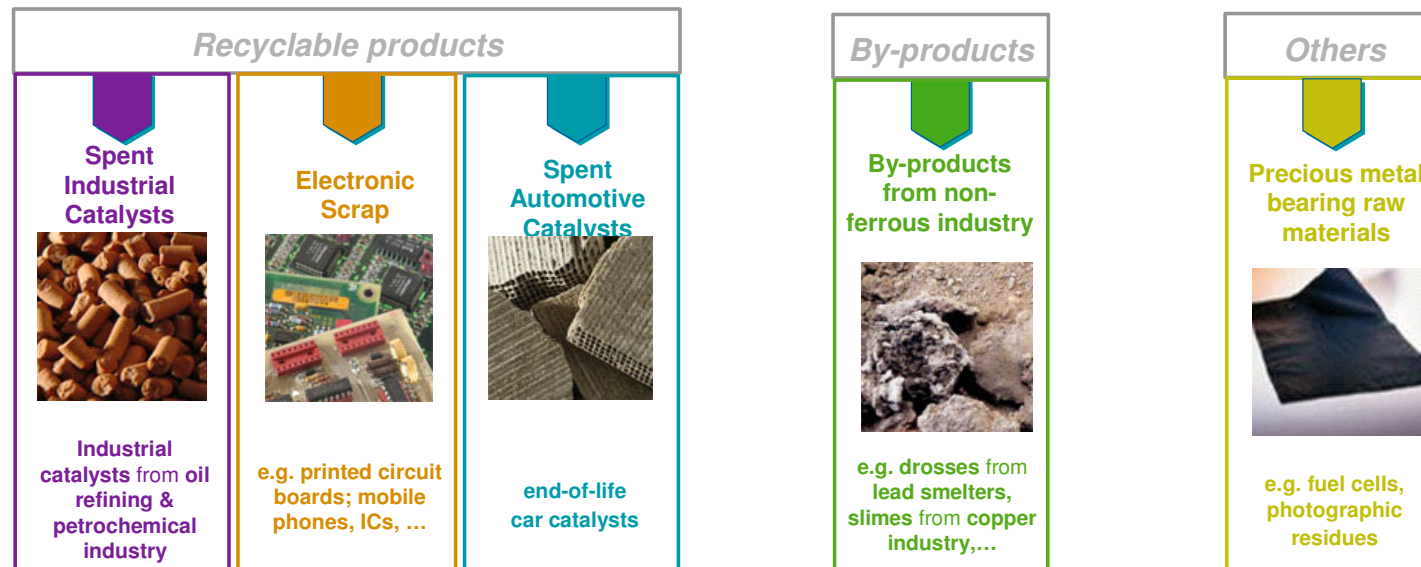
- 300,000 t/a of complex PM bearing feed materials
- PGM-output > 30 t/a
≈ 7% of world mine production
- Global customer base
- Minimizing waste (< 5%)
- High environmental standards (BAT) ISO 14001 & 9001
- > 1 billion € investment

Metals recovery: Umicore's BAT technology



Metals recovery: Umicore's BAT technology

Umicore Hoboken input:
300,000 tpy of > 200 different feed materials



In addition:

Umicore's Battery recycling technology in Hofors (Sweden)
Unique process for rechargeable Li-ion and NiMH





- **Reuse: PROs & CONs**

Reuse: positive elements

- Allowing “poorer” people to **bridge** the **digital gap** / to give **access** to IT/telecom
- Opportunity to generate **additional revenue** during collection / pre-processing => lower recycling costs which should ultimately lead to lower costs for new products bought by consumer
- Possible **extension** of a product’s **life-time** (=> *but is this desired?*)

=> Reuse has benefits, but **watch out for pitfalls**

Is reuse leading to less recycling and more pollution?

- reuse: often **blanket for export** of mere e-waste **to cheap, unsound destinations** (=> see Greenpeace and Basel Action Network reports)
- reuse **value** of **components** may be **higher** than **recycling value**
 - => material gets **exported** to low cost destinations
 - => **components** get **reused** with **rest** being **dumped / improperly recycled**
- at **final end-of-life**, is ESM refining option locally available ?
 - => re-export to ESM should be allowed
- **illegal reuse** of products/components



■ Challenges & Opportunities for North Africa

- ✓ What must be avoided in EOL treatment ?
- ✓ Implementing recycling technologies
- ✓ Recommendations

What must be avoided in end-of-life treatment



- Landfill, disposal
- Incineration
- Backyard recycling
- smelters *without* the appropriate offgas purification
- „Fake“ recycling (→ look further than a nice building, ISO & OHSAS certificates, a nice website → check material streams to the final destination)

Implementing recycling technologies

Collection / manual sorting & dismantling

- HIGH PRIORITY**
- Low investment cost**
- Use the strength of available workforce**
 - ✓ Involve informal sector & create skilled labour

Mechanical pre-processing (shredding/separation)

- Useful for high volumes of e-waste without or with low precious metal content (small domestic appliances, white goods, engines, ...)**
- Moderate investment cost**

Smelting/refining (resource recovery)

- Only useful if formal collection is organized**
- High investment cost**
- Big scale operations required to achieve high recovery yield & to make use of economy of scale**



Recommendations



- Assure **organized collection first** before thinking of high tech refining technology
- Create **legislative framework** that **promotes/facilitates formal collection & recycling** and that discourages/hinders informal recycling (and not the other way around)
- **If no collection → no recycling**

Recommendations



- **Maximize** the use of **manual dismantling** and minimize mechanical pre-processing as far as the *precious metals bearing e-waste* is concerned
- Offer **Reuse & Recycling** as a complete, integrated service
- The more complex/interlinked the material, the less selective are mechanical separation processes and the higher are **losses of precious metals** by co-segregation

Recommendations



- **End-processing** (physical materials recovery) is crucial for final value generation & toxic control.
- Recycling trace elements from complex products needs “high-tech”, large scale processes which cannot be replicated in any country.
- Use *synergy* of locally available workforce for dismantling/pre-processing and internationally available technology for materials recovery: economy of scale & international division of labour

Thanks for your attention



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