Managing complex lifecycles – closing the loop for precious & special metals

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Wuppertal Institute for Climate, Environment and Energy

EIIW

Precious & special metals have become irreplaceable for (consumer) product markets

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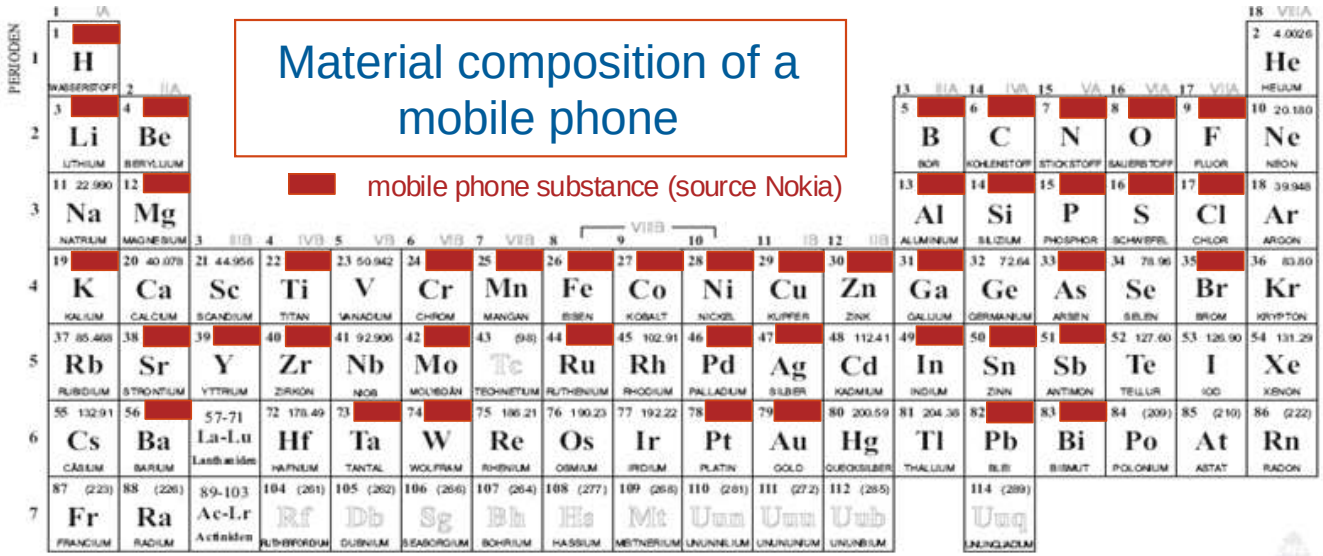
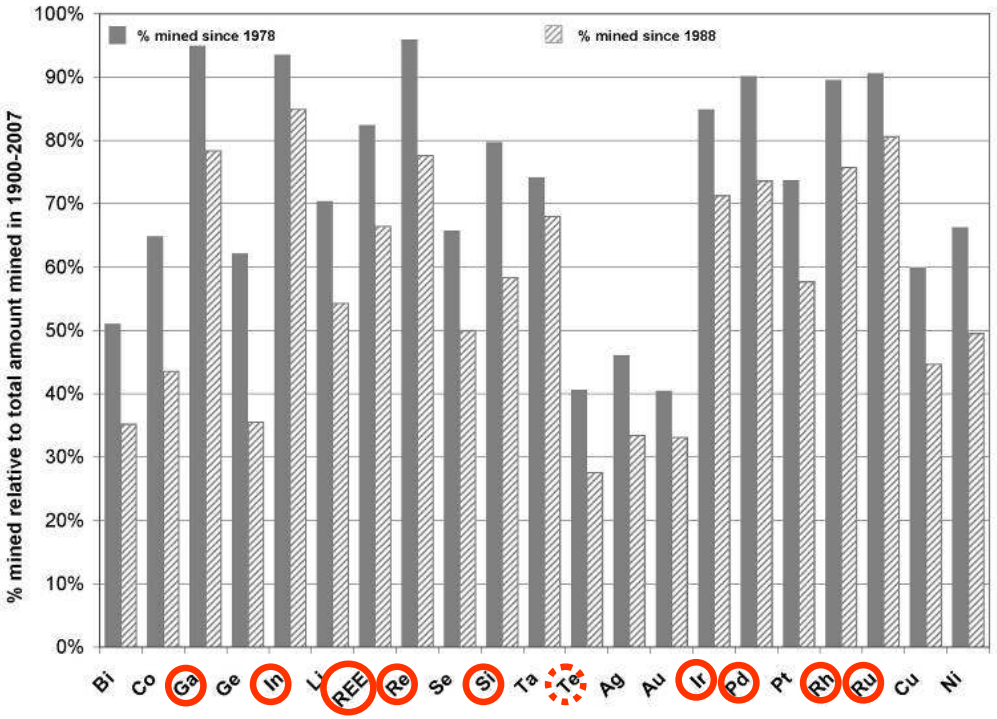
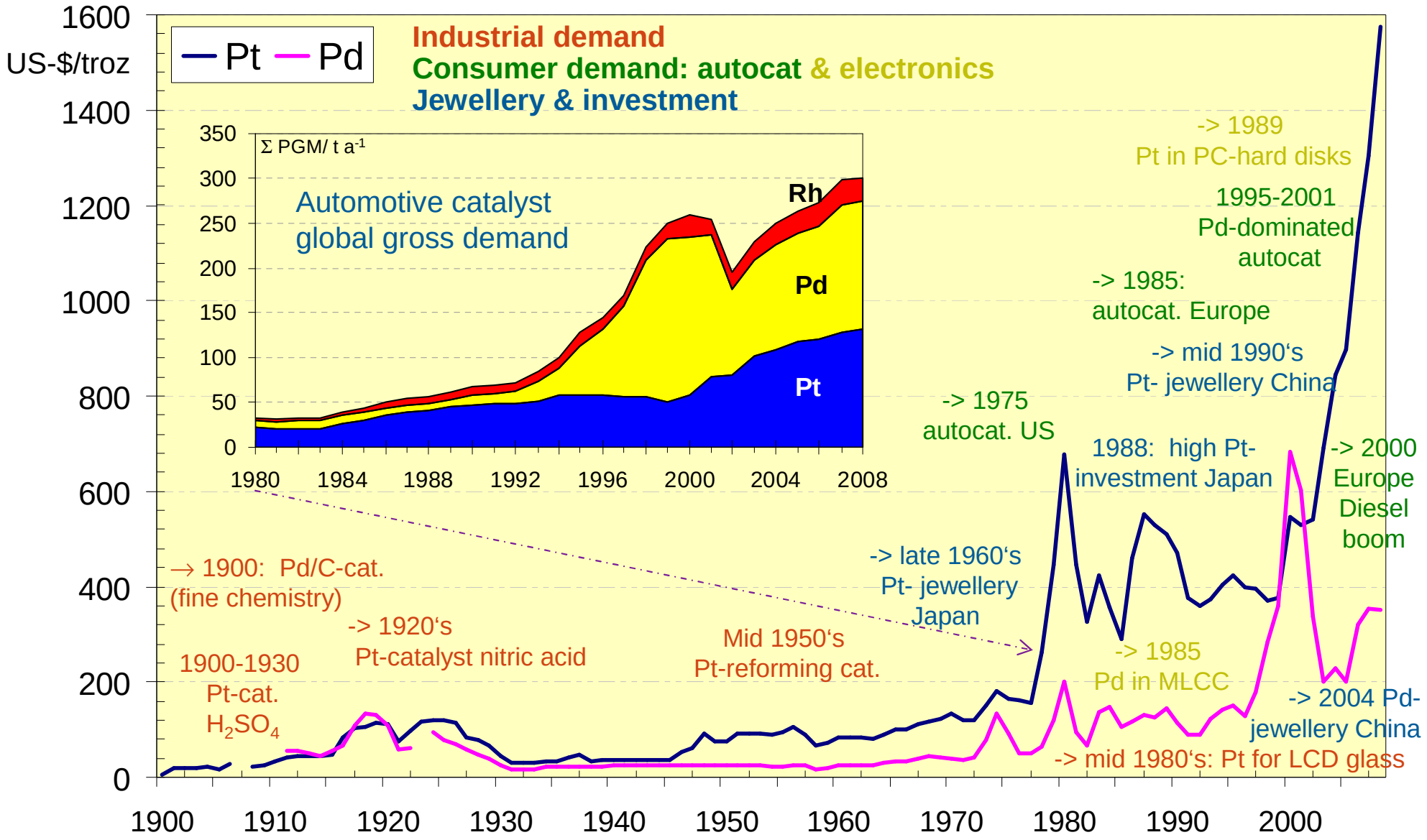


- „Technology metals“
  → crucial for functionality
- Booming demand since 20/30 years
- O > 80% mined since 1978
- Clean tech drives further growth



Example platinum / palladium: long term price development & milestones in use



Important clean-/high-tech applications competing for „affordable“ technology metals supply

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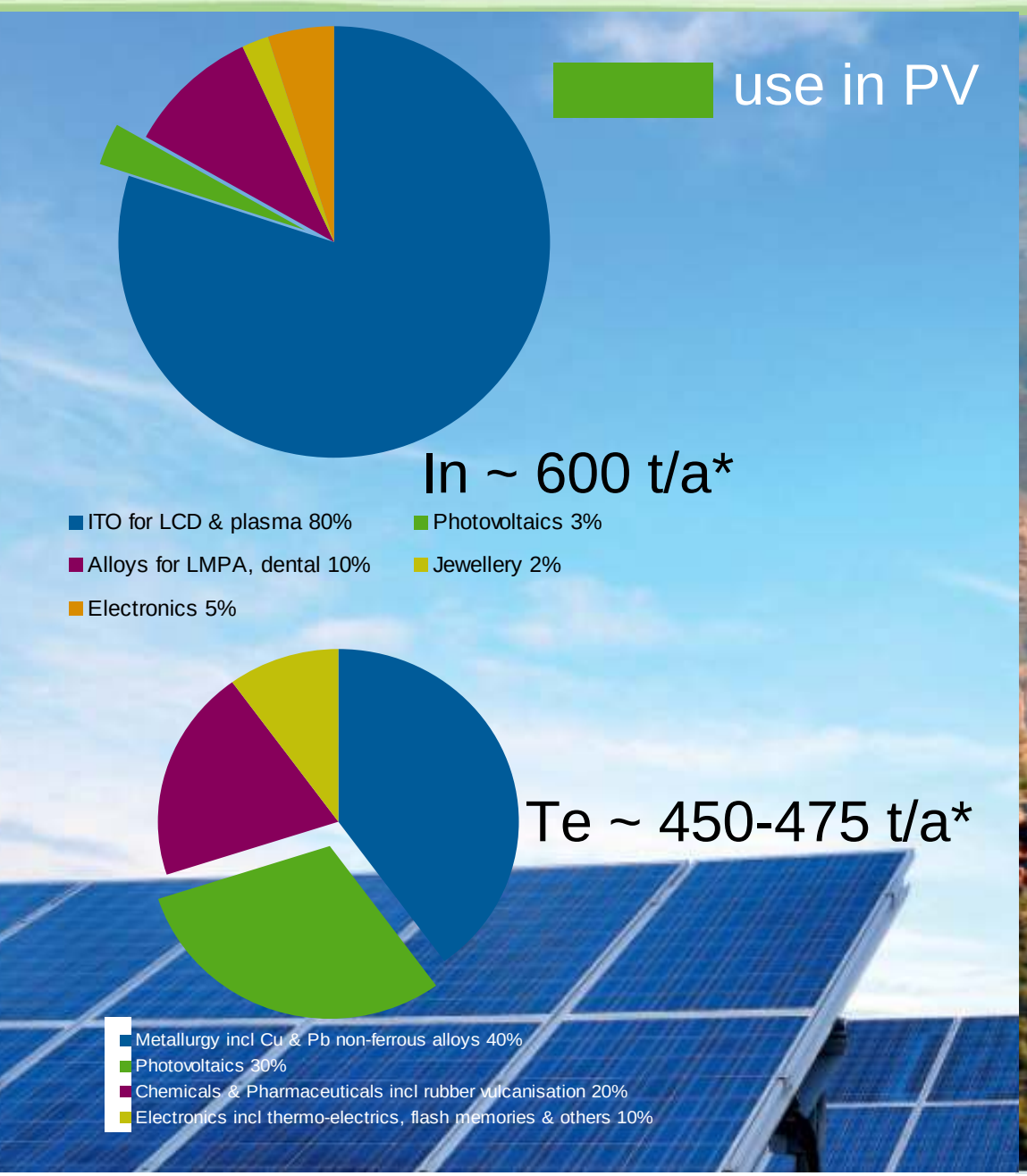
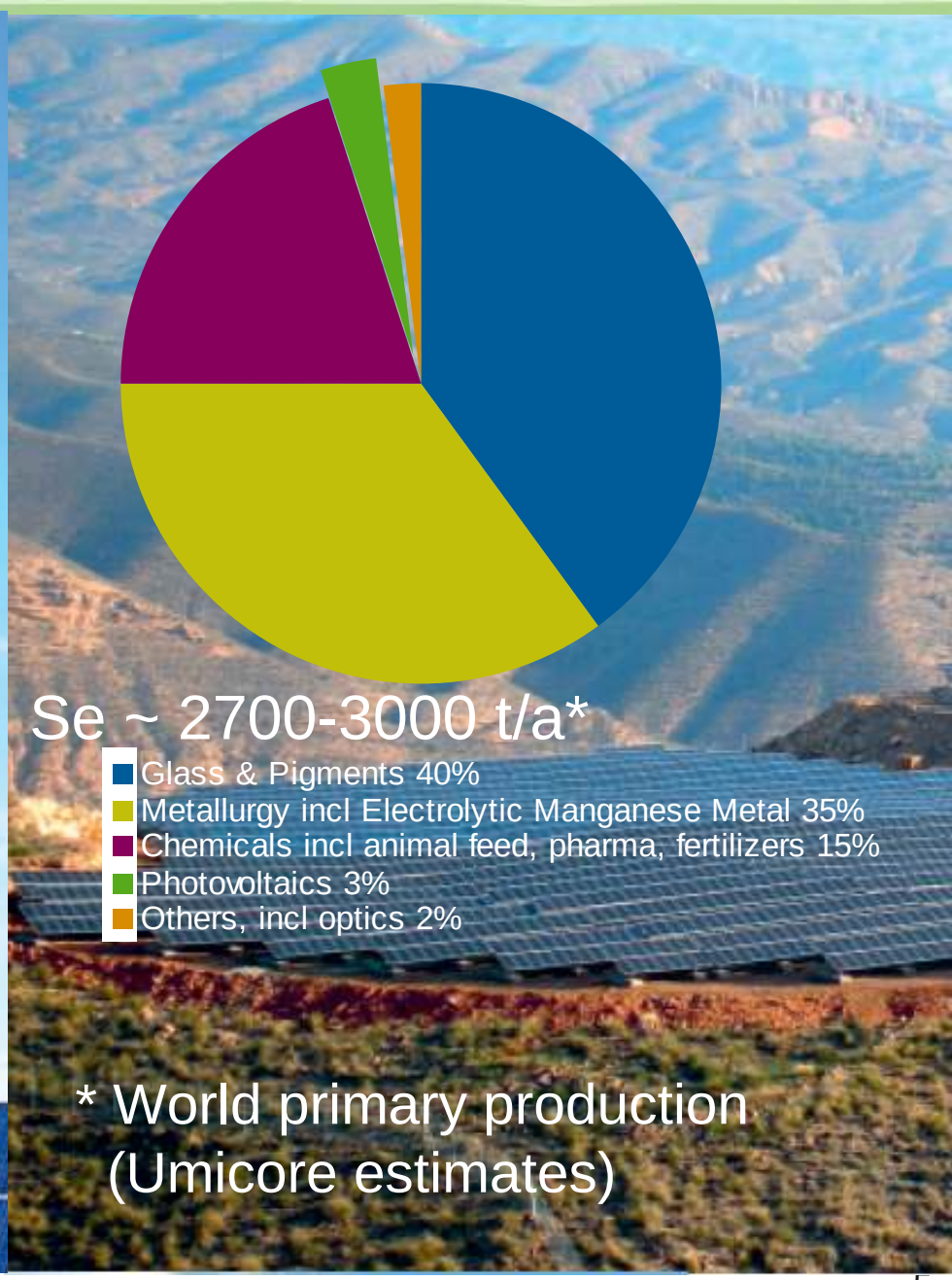
	Bi	Co	Ga	Ge	In	Li	REE	Re	Se	Si	Ta	Te	Ag	Au	Ir	Pd	Pt	Rh	Ru
Pharmaceuticals	■																■		■
Medical/dentistry		■	■	■	■			■	■		■	■	■	■		■	■		
Super alloys		■					■	■			■								■
Magnets		■					■		■			■							
Hard Alloys		■									■								
Other alloys					■	■		■	■	■		■							
Metallurgical*	■					■			■										
Glass, ceramics, pigments**	■	■			■	■			■			■	■			▒	■	■	
Photovoltaics			■	■	■				■	■		■	■						■
Batteries		■			▒	■	■						■						
Fuel cells						■										▒	■	▒	■
Catalysts		■		■			■	■	■			■	■	■	■	■	■	■	■
Nuclear					■	■	■												
Solder	■				■								■						
Electronic		■	■	■	■		■	■		■	■	■	■	■		■	▒	▒	■
Opto-electric			■	■	■		■		■	■		■							
Grease, lubrication			■			■													

* additives in smelting, …, plating. ** includes Indium Tin Oxide (ITO) layers on glass

Example indium, selenium, tellurium – strong growth expected in thin film photovoltaics (PV)





“Urban mining” – recycling can make an important contribution to future supply

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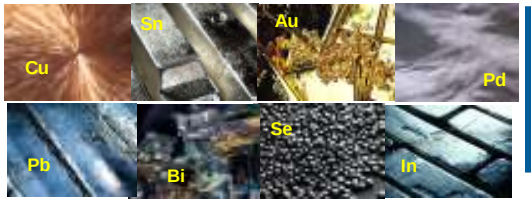
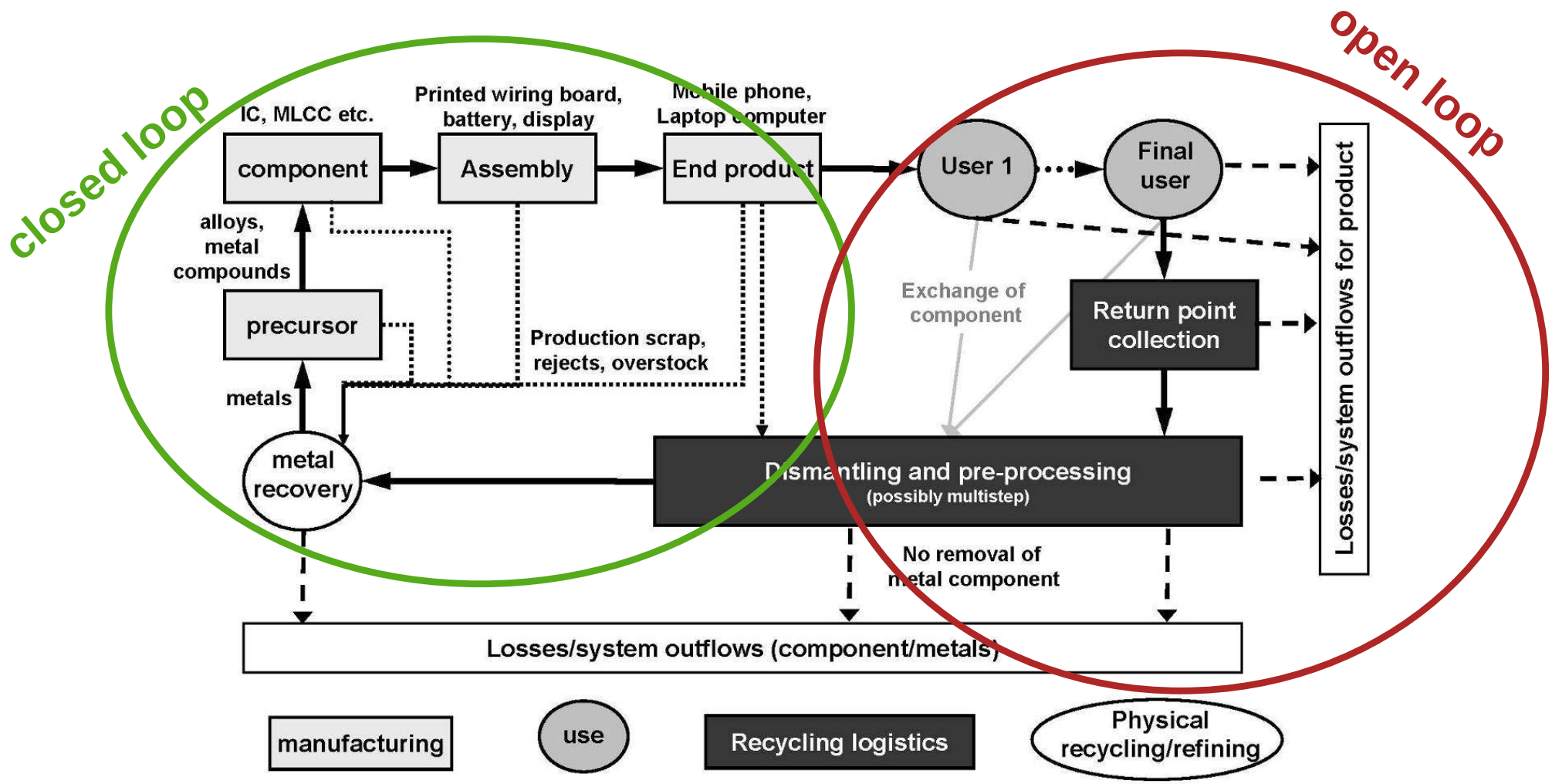


+ “Eternal” recycling of metals
+ High yields obtainable with state-of-the-art technologies
+ Significantly less CO_2/environmental footprint of modern recycling compared to mining (especially for precious & special metals)
- Economic & technical limits for dissipated metals
- Technical challenges within recycling chain for complex products with (e.g. ELVs, WEEE)
- Thermodynamic limits for certain metals from complex mixtures (Ta, REE, …)
- Challenges to effectively close the loop for end-of-life products

Complex lifecycles for precious & special metals – high losses for consumer products (open loops)



- High product mobility, unclear material flows
- Multiple change of ownership, sequential locations of use around the globe
- High exports of EoL products, lack of appropriate recycling infrastructure in developing countries

- Low consumer awareness on resource value & missing economic incentives, but combined mass flows have big impact on metal demand
- Hibernating goods, discarding as trash & informal activities reduce significantly recycling efficiency.

In spite of all efforts – mobile phone recycling largely fails today

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Recycling potential 2007: 500 million units per anno x 100 g = 50,000 t/a

collected | Not collected

%? %?

Recy-cling[1] | reuse

Stored "in drawer"
(potential for recycling at later stage)

Disposed with household waste
(unrecoverable loss)

%?

Use in 2nd life | Exported to deve-loping countries

Use in "2nd life"

Final end of life

EOL not collected

Recycling reality[2]: < 1000 t (< 10 M) in 2007

Collec-ted | Not collected

%?

Re-export to ESM-recycling

Local 'backyard recycling'[3]

[1] 25-35% of professionally collected phones are not fit for reuse and sent directly to recycling.

[2] global quantities treated for material recovery efficiently and environmentally sound

[3] low yields, uncontrolled release of fumes, effluents and waste

Global Sales of new phones:
2001: 400 M
2002: 420 M
2003: 520 M
2004: 670 M
2005: 800 M
2006: 990 M
2007:1140 M
2008:1320 M forecast

Not to scale

High-tech recycling is key - how to ensure that the right processes are used ?

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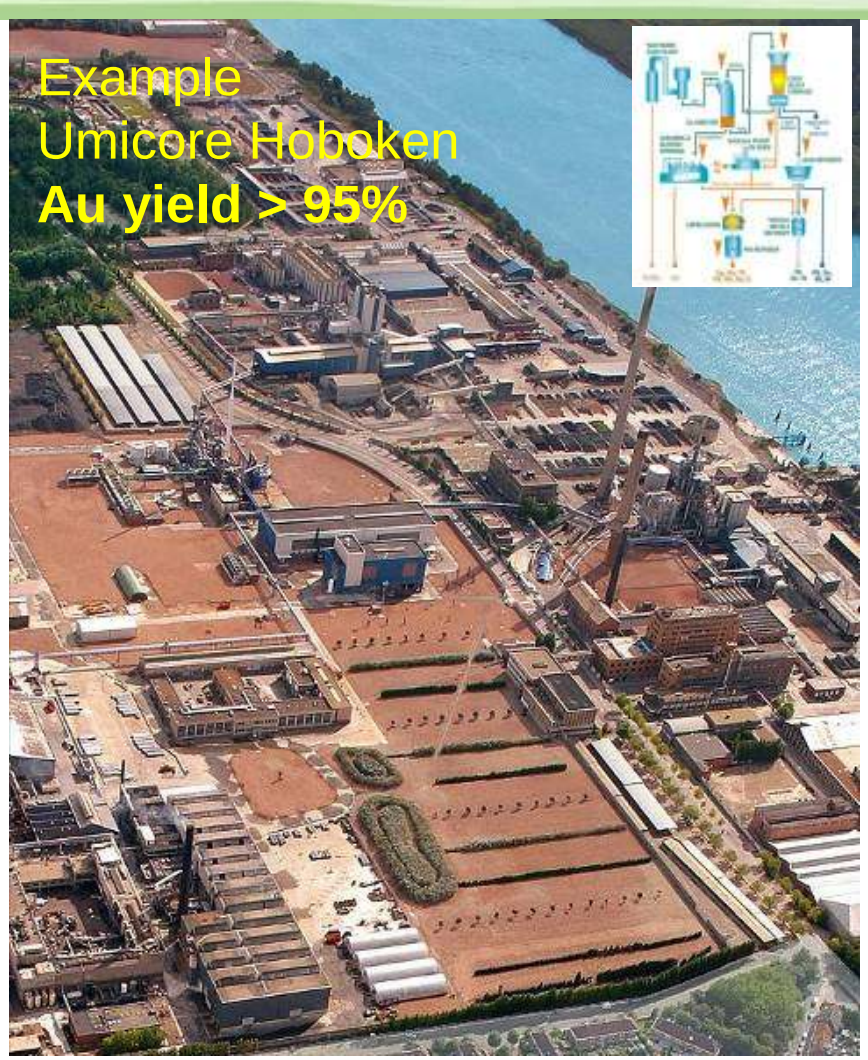


integrated metals smelting/refining ►"high tech"

backyard recycling ► "low tech"

- High losses, few metals recovered only (cherry picking)
- Dramatic environment & health impacts
- Typical for most Asian & African countries

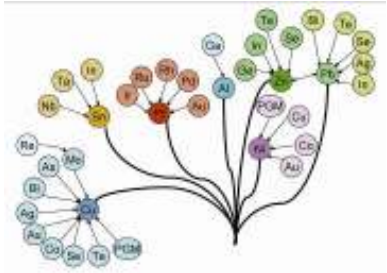
+ Focus secondary materials, input 1000 t/day
+ 17 metals recovered, value 3 billion USD (2007)
  (Au, Ag, Pt, Pd, Rh, Ru, Ir, Cu, Pb, Ni, Sn, Bi, Se, Te, Sb, As, In)
+ ISO 9001 & 14001, OHSAS 18001

Illegal & dubious WEEE & ELV exports deplete Europe's „urban mines"

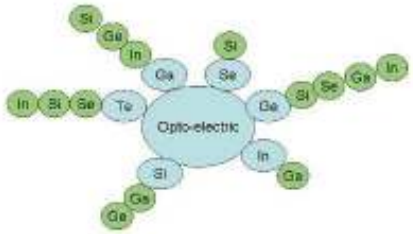
Recycling of technology metals needs to deal with complexity … and interdependences

design

Interlinkage metal production systems

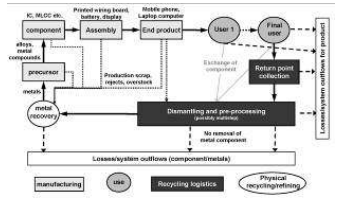


substitution

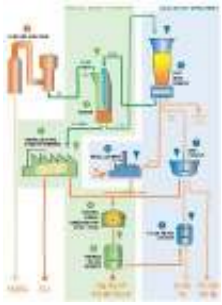


product composition

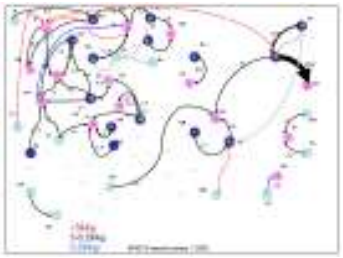
life cycle



metal recovery



Flows around the world

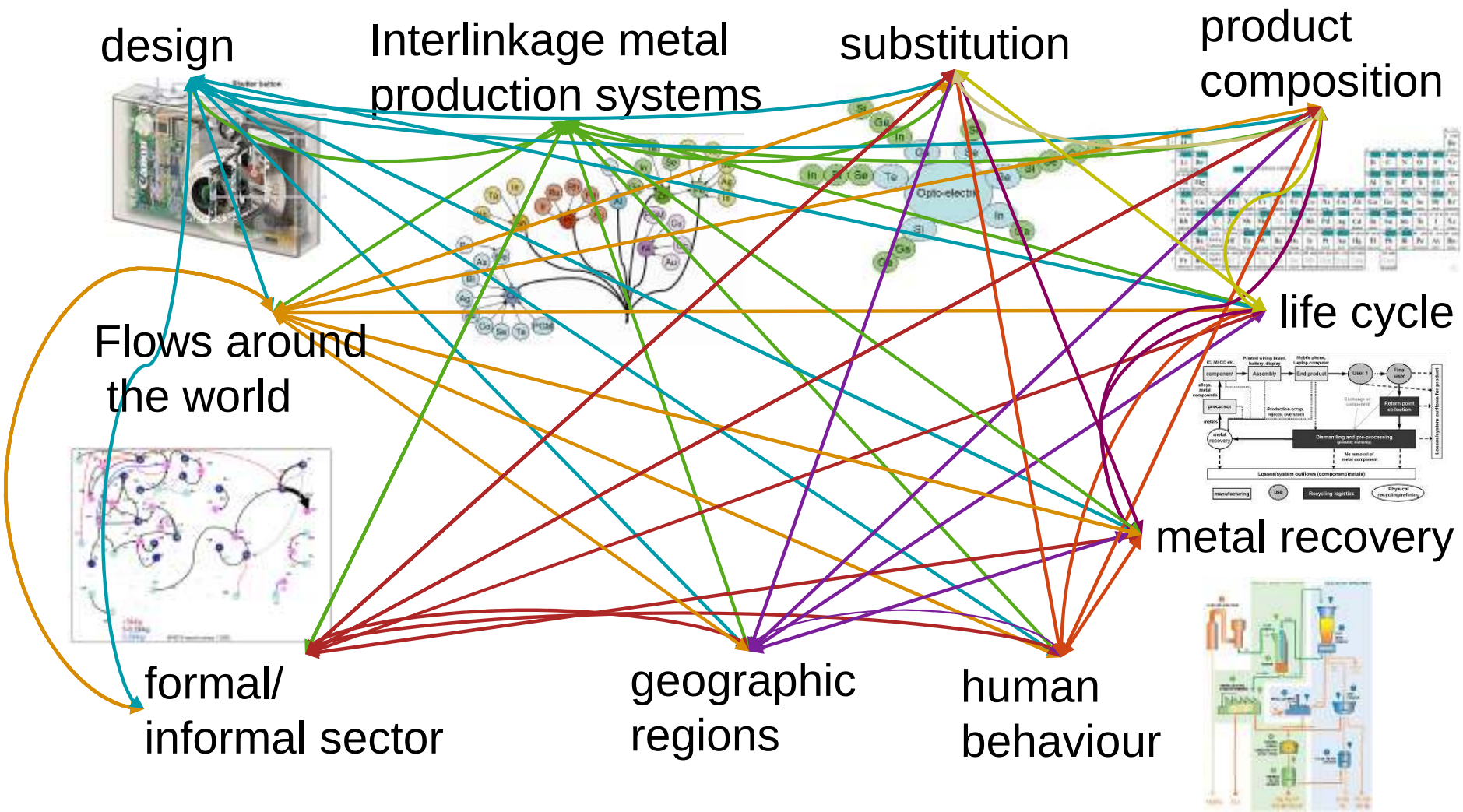


formal/ informal sector

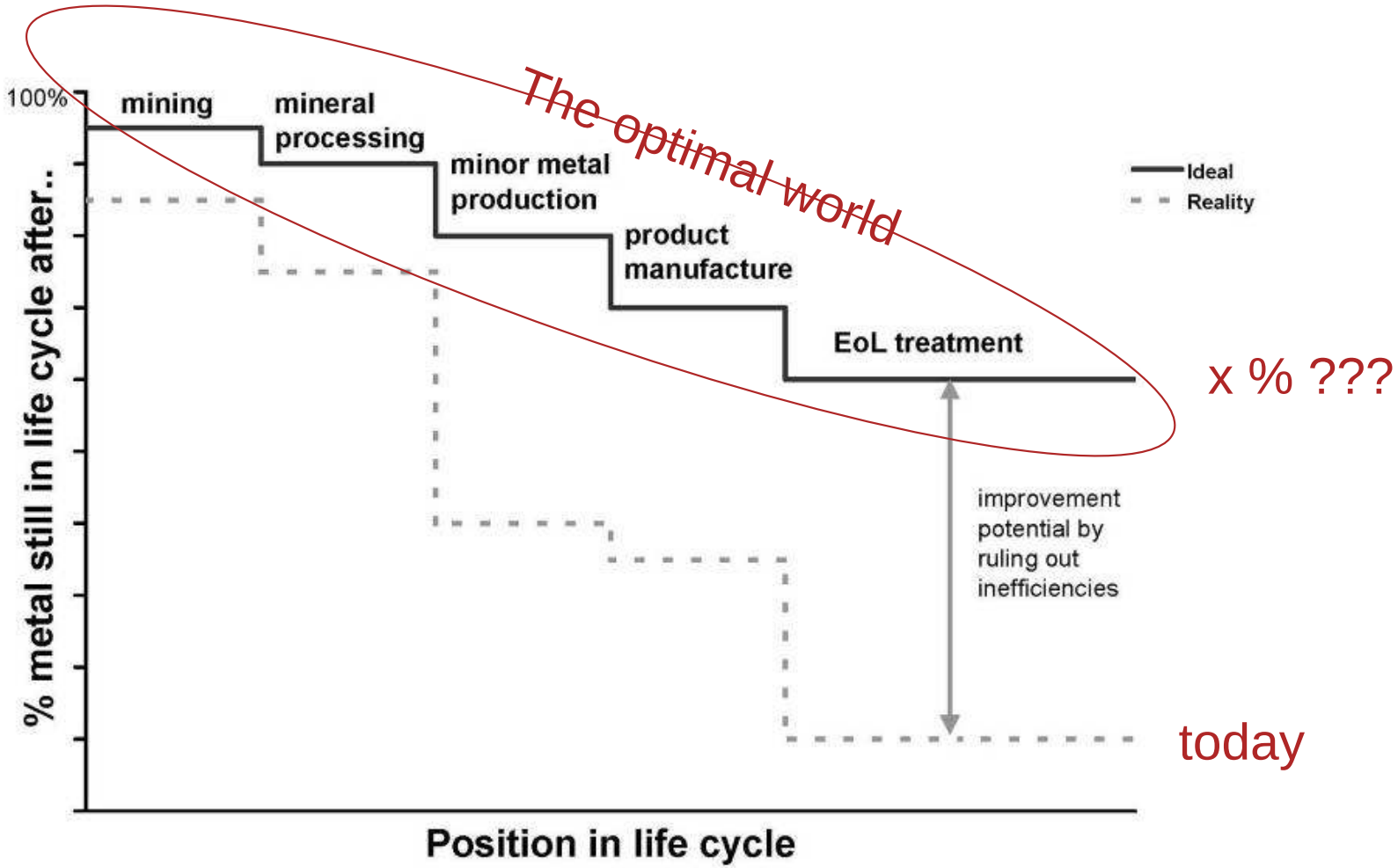
geographic regions

human behaviour

Recycling of technology metals needs to deal with complexity … and interdependences

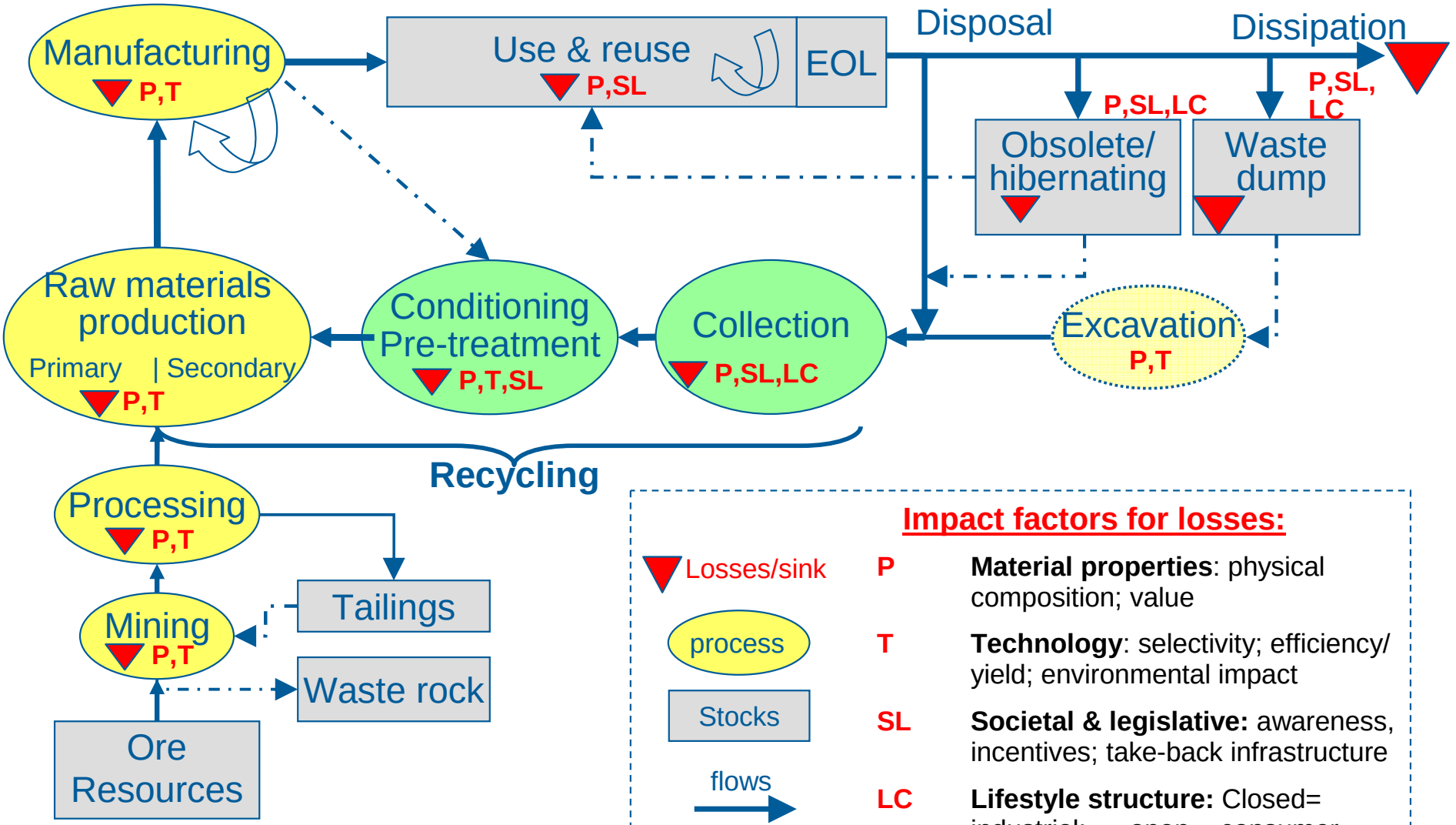


Resource efficiency can be improved on multiple levels … with huge potential in EoL treatment



… requiring a joint approach of the participants involved in the lifecycle

Losses and respective impact factors along a product/metals lifecycle



Closing remarks I

- Booming demand for precious & special metals (functionality); energy intensive mining; geographic concentration and high degree of coupled production can cause primary supply disruptions.
- Needed: Design for sustainability without losing product performance.
- High tech products require high tech recycling. Value of precious metals allows by-product recovery of special metals in Umicore type flowsheet.
- Recyclability of a product is not enough, it needs to happen at end-of-life.
- Main constraints are structural, not technical; “open cycles” for consumer goods → improve collection of consumer goods with technology metals.
- Research has to lead to (engineering) solutions → stop reinventing the wheel!
- Outreach to developing countries with knowledge transfer and solution-oriented new approaches/business models.
- Efficient recycling & responsible mining are needed to meet future metals demand.

Closing remarks II

Complex products need sophisticated recycling systems

► *simplistic approaches are not useful*

Closing the cycle should be done globally…

► *holistic approach to life cycle, recycling chain and location*

…at different levels

► *system, product, process,…*

…and look at all the factors

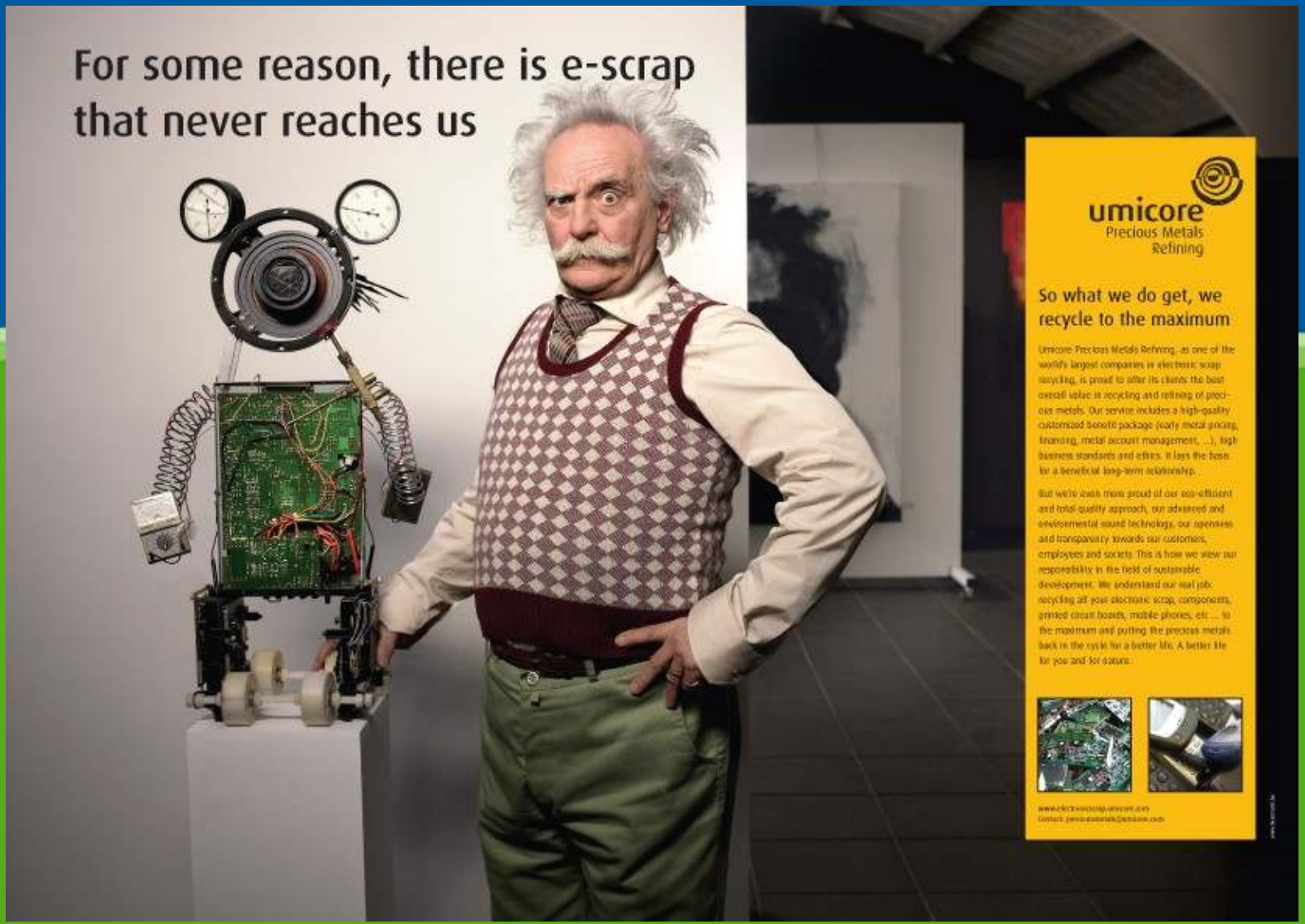
► *technology, societal, legislative, economic…*

Push interdisciplinary approaches addressing complexities in a holistic way
► material science + metallurgy + mineral processing + social science + sales/marketing

A „recycling society“ is impossible without closed loops for consumer goods.
→ New business models required, e.g. leasing products/ components/metals or selling functionality/services instead of selling products. Set up early recycling incentives for new products (PV, EV/HEV batteries, fuel cells etc.)

Thanks for your attention

For further information: Hagelüken, C., C.E.M. Meskers: Complex lifecycles of precious and special metals, in: Graedel, T. , E. van der Voet (eds): Linkages of Sustainability. Strüngmann Forum Report, vol. 4. Cambridge, MA: MIT Press, 2009



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