Urban Mining and the recycling of E-Waste

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EuChemS
1970-2020
European Chemical Society

Umicore

Global material technology- & recycling group

~ 11150 people, 50 production sites & 15 R&D technical centers, 3,4 bn € revenues*

1

One of three global leaders in emission control catalysts for light-duty and heavy-duty vehicles

2

A leading supplier of key materials for rechargeable batteries and fuel cells

3

The world leading recycler of complex waste streams containing precious and other valuable metals

*2019 without metals

Urban mining “deposits” - much richer than primary ores

- **Primary mining**
  - << 5 g/t Au in ore
  - Similar for PGMs

- **“Urban mining”**
  - 100-150 g/t Au; Pd, Ag, Cu, Sn, Sb, … in PC motherboards
  - 200-300 g/t Au; Pd … in cell phones

factor 20
& more

How to accumulate millions of discarded EoL product into „urban mines”
of a reasonable (= economically viable) size?

Effective collection crucial for economic viability

Responsible recycling to cope with hazards while recovering value

- Metal value of 1 smart phone: ~ 1,1 €
- Net value of 5 t of phones at gate of Umicore recycling plant: up to 50,000 €
- Metal value of 1.8 B mobile phones sold globally in 2019: ~ 2 B €

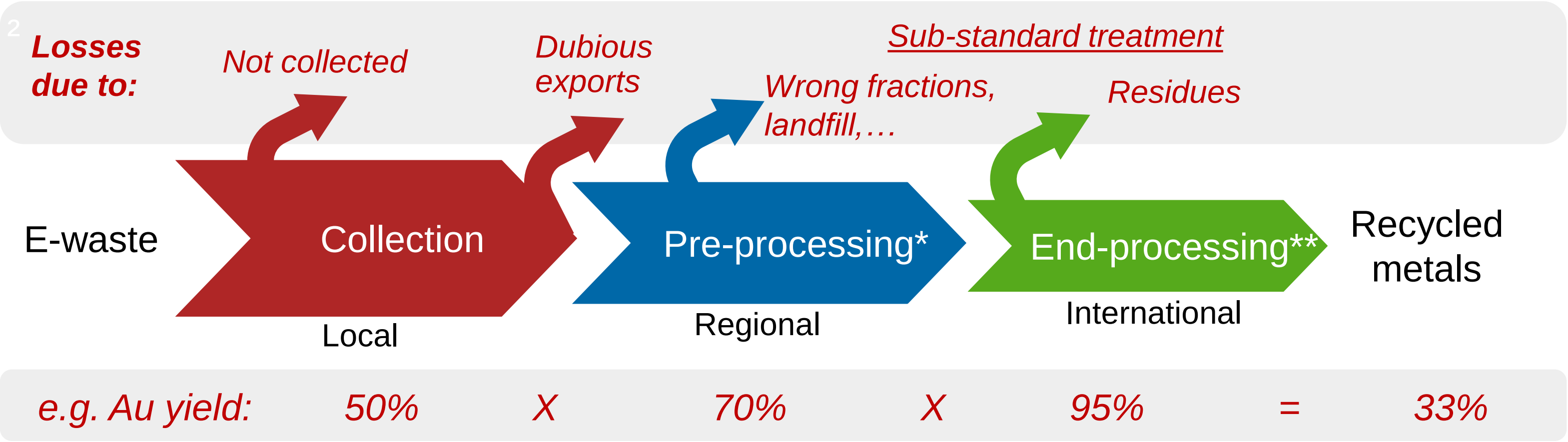
⇨ E-scrap / mobile phones, a complex mix …

- Ag, Au, Pd… (precious metals)
- Cu, Al, Ni, Sn, Fe, Bi, Sb, In… (base & special metals)
- Hg, Be, Pb, Cd, As, …(hazardous substances)
- Halogens (Br, F, Cl...)
- Plastics & other organic materials
- Glass, ceramics, wood, …

⇨ Environmental risk in case of landfill/bad recycling

⇨ Important source for raw materials (incl. CRM)

Effective recycling requires optimised chains



* manual-mechanical
** chemical-metallurgical

Main recycling drivers:

- Economic value, business models & legislation (if well enforced)

Main challenges:

- Insufficient collection, illegal waste exports, sub-standard treatment
  ⇒ high metal losses & environmental damage
- Reported „Recycling rates“ are rather collection rates, don’t reflect the physical truth

Metallurgical end-processing – example Umicore

Economies of scale & sophisticated processes needed for multi-metals recycling

Umicore’s integrated precious metals refining plant in Hoboken, Belgium

- Efficient recovery of 17 metals in main process:
  Au, Ag, Pt, Pd, Rh, Ru, Ir, Cu, Pb, Ni, Sn, Bi, Se, Te, In, Sb, As
- Treatment of e-scrap fractions, catalysts, …, industrial wastes, smelter residues, complex mining concentrates, …
- Up to 500,000 t/y materials input, global sources
- In addition, specialized process for recycling of Li-Ion batteries recovering Co, Ni, Cu, Li
- Unique technology, high metal yields, energy efficiency & EHS-standards

EoL materials need to reach such plants!

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Still significant efforts needed to become circular

if we strive to close the physical loops for (electronic) products

- True CE requires a fundamental change in the way we develop, design, use and recycle products that have a high relevance for (critical) raw materials.
- Both, recycling and lifetime extension/use optimisation need to be addressed in the CE strategy.
- Companies have to adapt their business models accordingly. New forms of stakeholder collaboration ("roundstream" instead of up-/downstream) and product service models can be the game changer ("business as unusual").
- Incentives & appropriate legal frame conditions needed to secure comprehensive collection and high quality recycling.
- Special focus on CE strategies is required for electronics and green products as they increase the demand for (critical) raw materials and need to be inherently sustainable by definition.

Thanks for your attention

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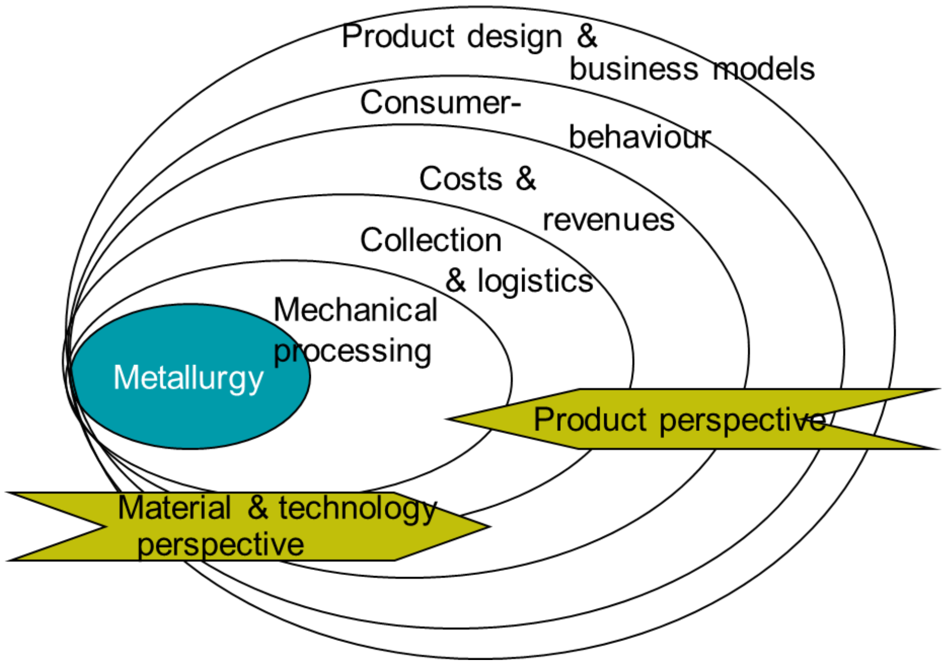
Overall recycling success factors



Prerequisites:

1. Technical recyclability as basic requirement
2. Accessibility of relevant components → product design
3. Economic viability
   intrinsically or externally created
4. Comprehensive collection
5. Transparency of real flows
6. Use of best performing recycling infrastructure
7. Optimal technical-organisational set-up <u>of chain</u>

Complex products require a systemic optimisation & interdisciplinary approaches
(product development, process engineering, metallurgy, ecology, social & economic sciences)

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Keeping materials in the loop
basic requirements for a circular economy

- ➢ Physical: Reapply recycled materials into new products
  - → *EHS-compliant, multi-material recovery from complex products*
  - → *focus on quality & performance of applied recycling processes*

- ➢ Economical: matching revenues & costs of entire recycling chain
  - → *comprehensive collection, chain optimisation, economies of scale*
  - → *special challenge for high quality recycling of critical materials from complex consumer products*
  - → *close economic gap if needed, generate adequate recycling drivers (fees, business models, …)*

- ➢ Not “any” recycling operations but only high quality processes fit for a Circular Economy

Circular economy in a global business environment:
→ reuse & recover materials comprehensively at product EoL, when ever & where ever this will be

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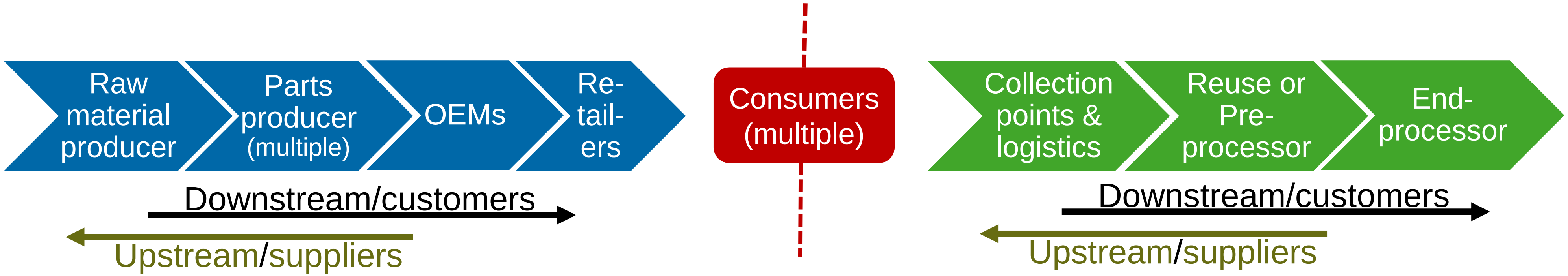
Current barriers to closing the loop

Lifecycle is disconnected @ consumer → 2 <u>independent</u> value chains in B2C



- Focus on direct customer/supplier interfaces, missing system approach & overarching collaboration
- No real incentives for OEMs for durable, well repairable & recyclable products
- Processes, tools and financial systems in companies are tailored to linear business
- Little knowledge (and interest) on “fate” of products after it’s distribution
- @ EoL: Too much focus on costs/prices – too little on recycling quality
- Current EPR systems do not reward comprehensive and good recycling
- OEM focus is more on legal compliance and image (CSR, responsible sourcing, recycled content, …), so far less on genuine circular business models

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Recycling economics – what's the right price for "waste"?

$$\text{Waste price} = \underbrace{\text{recoverable material value}}_{\sum \text{material content x mat. price}} - \underbrace{\text{recycling chain costs}}_{} \;(+ \text{ recycling fee*})$$

∑ material content x mat. price

product composition & market trends
(pollutants can have negative value)

Recycling chain costs — Impacted by:

- Technical performance
- Process chain efficiency
- Factor costs (labour, energy, capital)

→ Recycling industry

- Available volumes/economies of scale
- EHS-performance (incl. reporting & hazardous emissions control)

→ Legislation & enforcement

- *Shipping costs (incl. taxes, customs)*
- *Administrative costs (incl. time delays)*

→ *Trade regulations*

CHATHAM HOUSE The Royal Institute of International Affairs
OECD BETTER POLICIES FOR BETTER LIVES

C. Hagelüken @ Expert Roundtable on Trade and the Circular Economy
Session 2: Circular Economy & Trade in Critical Materials, 20.4.2018, OECD Paris

*legislation, business model to cover externalised costs

- *Complex waste* (mix of valuables & pollutants): "externalisation" of EHS-costs enables high waste prices
- *Cost savings* of non-compliant/low quality processes often outweigh *costs for waste exports*
- *Administrative burden* & time delays for transboundary hamper waste shipments to high quality recyclers

→ The lack of level playing field for EHS-compliant, quality recyclers hampers the circular economy