Metals Recycling - Challenges and Strategies

UNIDO Global Meeting, 14.11.2018, Vienna:

Circular Economy: Development of Recycling Industries

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IWKS
Ressourcenstrategie
Recycling und Wertstoffkreisläufe
Substitution

https://www.unido.org/news/unido-and-bureau-international-recycling-agree-closer-cooperation

Metals Recycling:
Substitution of Primary Resources

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Steel is the World's Most Recycled Material

https://www.steelsustainability.org/recycling

"*Metals are infinitely recyclable in principle…*"

Source: Reck/Graedel 2012

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Sustainable Development Goals and Metals Recycling

http://www.un.org/en/development/desa/population/theme/sdg/index.shtml

Energy and Mitigation of Climate Change

- The production of iron, steel and aluminum accounts for **10 % of total manufacturing energy use**.
- Secondary production requires about **74 %** (steel), respectively **90 %** (aluminum) **less energy** than primary production.

Source: EIA https://www.eia.gov/todayinenergy/detail.php?id=16211

Sustainable Development Goals and Metals Recycling

http://www.un.org/en/development/desa/population/theme/sdg/index.shtml

Environment: Water, erosion, biodiversity, toxic substances

- Roughly 70 % of mining operations of the world's six biggest companies are in countries **facing water stress**.
- Poorly managed mining operations can pollute the environment and **damage the biodiversity**.

Source: UN https://www.unenvironment.org/explore-topics/extractives/why-does-extractives-matter

Sustainable Development Goals and Metals Recycling

http://www.un.org/en/development/desa/population/theme/sdg/index.shtml

Livelihood and health

- Up to 100 million people make a living from **artisanal mining**.
- High **health risk** for the workers and the surrounding community.

Sources: Umair 2015, https://www.unenvironment.org/explore-topics/extractives/why-does-extractives-matter
http://www.wiego.org/informal-economy/occupational-groups/waste-pickers#size
https://tcocertified.com/news/e-waste-hazardous-to-the-environment-and-human-health/

Recycling Rates of Metals

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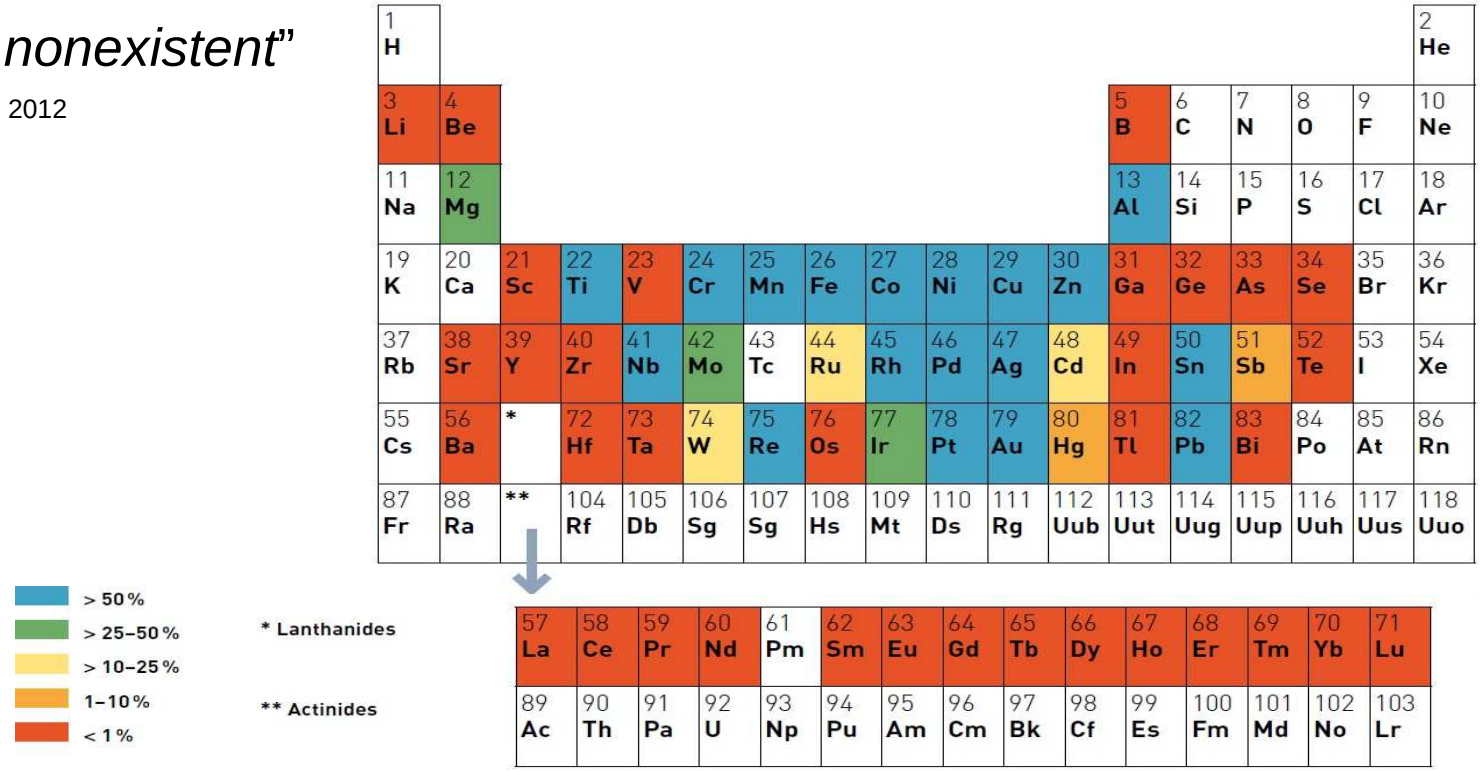
"Metals are infinitely recyclable in principle…

…but in practice, recycling is often inefficient or essentially nonexistent"

Source: Reck/Graedel 2012



Source: T. E. Graedel et al., UNEP Status Report 2011

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Barriers and Challenges

http://www.notebookinfo.de/

https://discardstudies.com/2012/03/26/singapore-is-a-gold-mine-re-orienting-global-tr
flows-of-secondhand-electronics-guest-post-by-creighton-connolly/

http://www.techfieber.de/green/2010/08/17/studie-oko-instituts-zeigt-chancen-fur-nachhaltiges-elektro-schrott-recycling-in-ghana/

Barriers and Challenges: The Waste Management Perspective (I)

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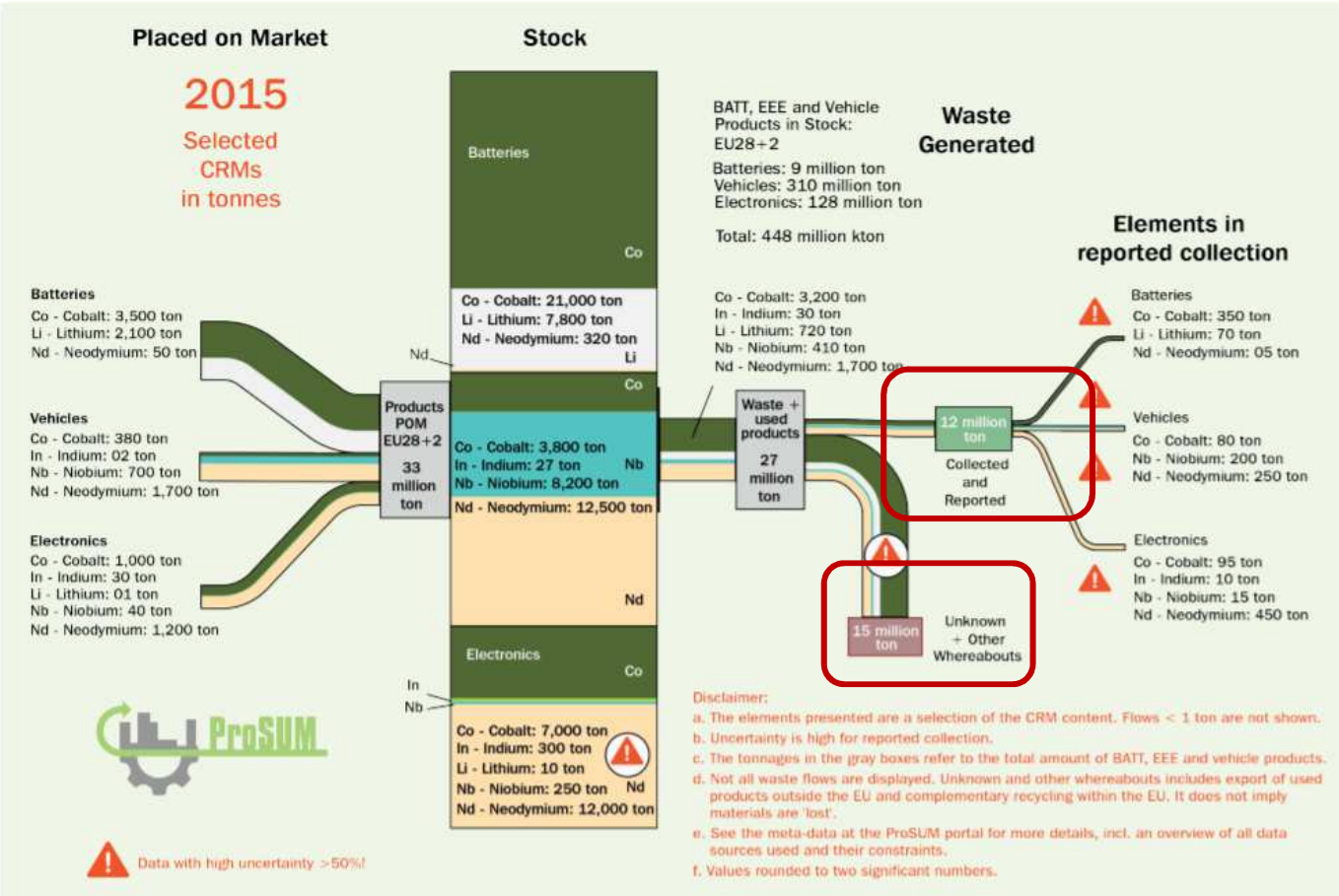
Waste flows Europe: Example Batteries, Vehicles, Electronics



Total: 27 mio t
Collected: 12 mio t
Unkown: 15 mio t

Source:
Huisman et al. 2017

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Barriers and Challenges: The Waste Management Perspective (II)

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Waste Management in developing countries

https://discardstudies.com/2012/03/26/singapore-is-a-gold-mine-re-orienting-global-trade-flows-of-secondhand-electronics-guest-post-by-creighton-connolly/

Barriers	
Technical	• deficient infrastructure • difficulty of separation • increasing complexity of products • lack of effective materials recovery technologies
Regulatory & Institutional	• lack of effective collection mechanism networks • lack of adequate regulations • shortfall of professional management • accountability
Socio-economic	• lack of financial incentives • lack of knowledge • unequal sharing of the costs and benefits of recycling

Sources: Pollmann et al. 2018, Conke 2018, Tansel 2017

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Barriers and Challenges: The Socio-Economic Perspective (I)

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Informal waste recycling –

Waste picker

http://www.techfieber.de/green/2010/08/17/studie-oko-instituts-zeigt-chancen-fur-nachhaltiges-elektro-schrott-recycling-in-ghana/

- Probably millions of people worldwide **earn their living** from **informal recycling waste**
  - E.g. Brazil: over 229,000 waste pickers => responsible for the high recycling rates in Brazil (nearly 92 % aluminium recycled in 2008)
- Exposure to hazardous materials/inhalation of toxic gases, e.g. burning of wires
- Child labor is common practice, no social security/no benefits for workers.

Sources: Umair 2015,
http://www.wiego.org/informal-economy/occupational-groups/waste-pickers#size
https://tcocertified.com/news/e-waste-hazardous-to-the-environment-and-human-health/

Barriers and Challenges: The Socio-Economic Perspective (II)

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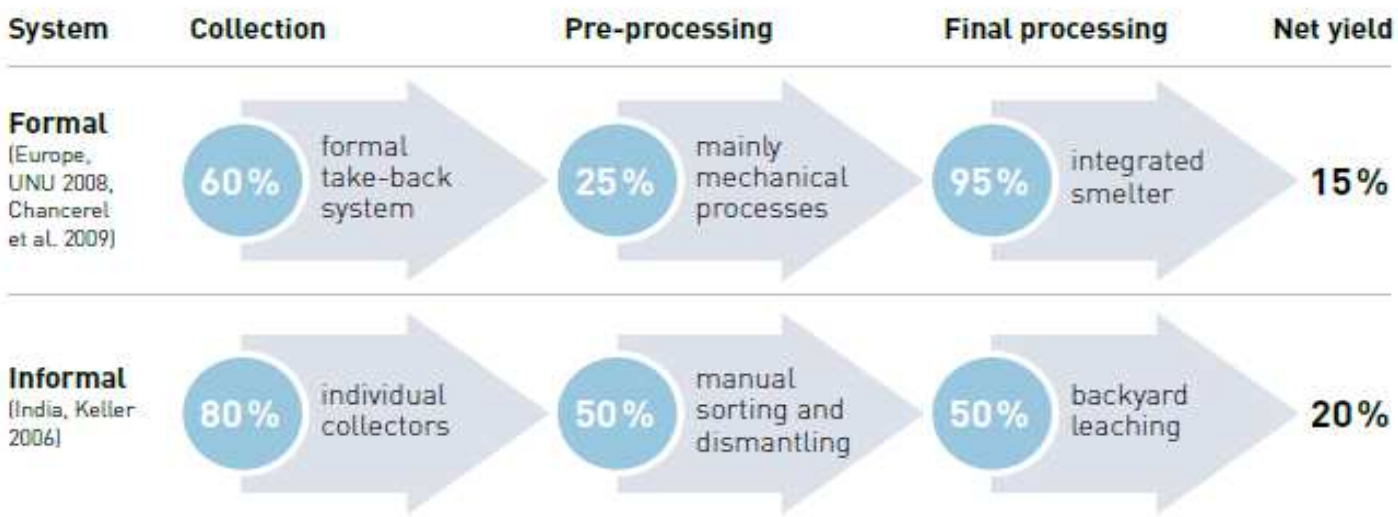
Material Flows from Collection

to Final Processing:

example gold recycling from printed wiring boards

http://www.techfieber.de/green/2010/08/17/studie-oko-instituts-zeigt-chancen-fur-nachhaltiges-elektro-schrott-recycling-in-ghana/



Source: IRP (2017): Green Technology Choices

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Barriers and Challenges: The Material Flow Perspective (I)

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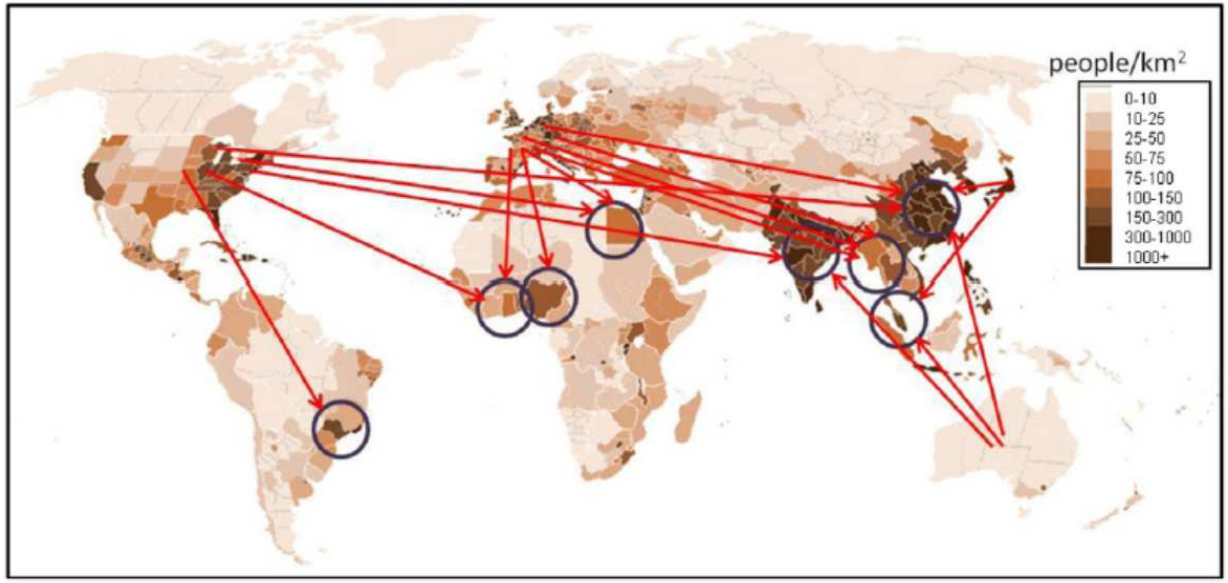
Global tracebility: example e-waste:

- lack of a universal definition of e-waste
- no international trade data that distinguishes between new and used commodities
- role of illicit trade



Sources:
Lepawsky 2015, Tansel 2017

Fig. 3. Cross boundary transport of e-waste to major disposal and recycling locations transposed on population density map (sources: e-waste flows and recycling locations: Lundgren, 2012; Chen et al., 2011; Lewis, 2011; UNEP, 2013; World population density map: Worldometers, 2015).

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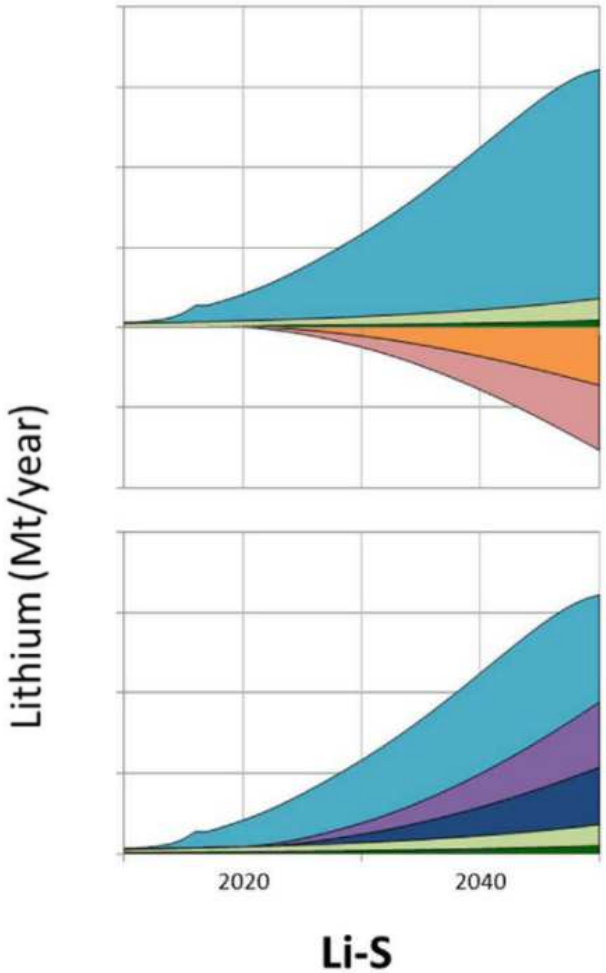

Scenario A – open-loop recycling: secondary LiC to Basic Demand (except rechargeable and EV-batteries)

Scenario B – closed-loop recycling secondary LiC to rechargeable and EV- Batteries

Example Lithium:
Recycling-Loops

- Primary Li for EV-batteries
- Primary Li for basic use sectors
- Secondary Li oversupply (40% RR)
- Secondary Li oversupply (80% RR)
- Secondary Li for basic use sectors
- Secondary Li for EV-batteries (40% RR)
- Secondary Li for EV-batteries (80% RR)

Source: Ziemann et al. 2018

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Barriers and Challenges: The Technical Perspective (I)

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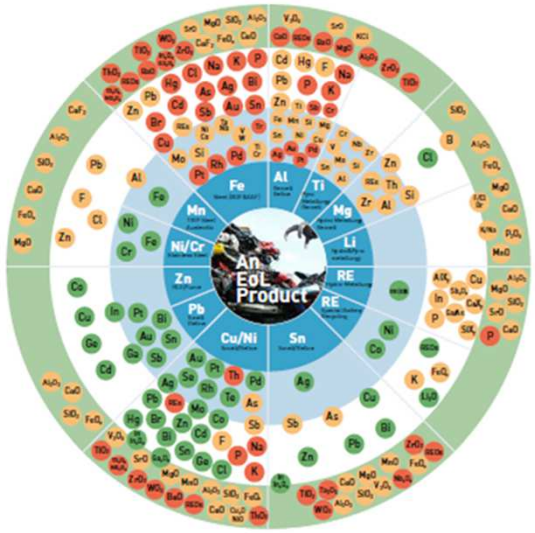
Material cycles and dissipative losses:

- Critical raw materials in alloys, but **no exact data** on amount of **critical raw materials in metal scrap**
- As to new high-grade steel and other alloys, the scrap metal needs to be **well sorted** or the materials will be **lost to downcycling**
  (Hiebel & Nühlen 2016)
- "*metal recycled from old scrap largely serves as an imperfect substitute for primary metal*"
  (McMillan 2012)



https://www.wrforum.org/wp-content/uploads/2015/03/Metal-Recycling-Opportunities-Limits-Infrastructure-2013Metal_recycling.pdf

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Barriers and Challenges: The Technical Perspective (II)

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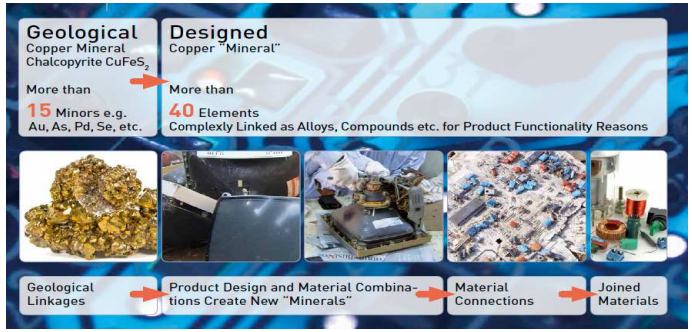
„Product-Centric approach“: recycling targets components of a product, separating and recovering them.



https://www.wrforum.org/wp-content/uploads/2015/03/Metal-Recycling-Opportunities-Limits-Infrastructure-2013Metal_recycling.pdf

https://www.nabu.de/umwelt-und-ressourcen/aktionen-und-projekte/alte-handys-fuer-die-havel/19366.html

- „Design for Recycling“ vs. **rapidly changing designs** and **more complex products**
  => barrier for recycling (Punkkinen et al. 2017)
- Only **selective recovery** of single elements
  - e.g. Cobalt from Li-Ion batteries
- novel technological routes for material recovery – **„upcycling“, „functional recycling“**

https://www.mawi.tu-darmstadt.de/media/fm/homepage/presse_2/White_Paper_TUDa_UM_magnetic_refrigeration.pdf

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Conclusions

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Ample evidence of barriers => Challenges:

- **Tracebility of material flows**: control of illicit trade; classification schemes and data of material flows as a global knowledge base
- **Waste management in developing countries:** comprehensive solutions covering technical support, inclusion of the informal sector, professional training and incentives
- **Recovery of critical raw materials**: technologies for specific materials and products; establishment of value chains
- **Strategic planning**: much more ambition for „Design for Recycling“: scenarios planning for future material flows

Thank you for your attention!

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