Challenges in closing the loop for special metals

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Umicore Precious Metals Refining

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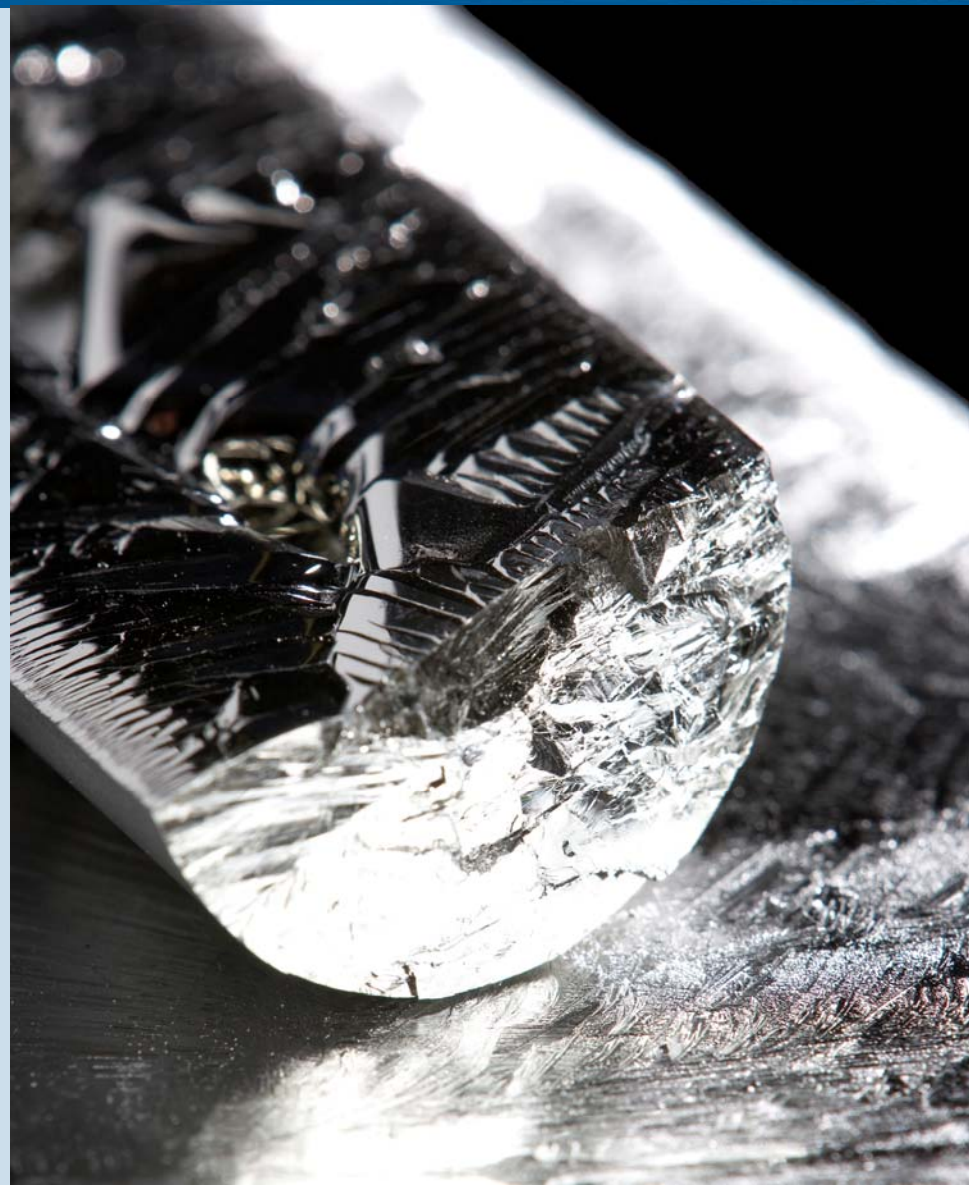
Agenda

I Introduction

II Why should we bother?

III Challenges in closing the loop

I Introduction



Today, our company is…

- … one of the world's biggest suppliers of automotive catalysts for passenger cars
- ... is the world's largest recycler of precious metals from old mobile phones, laptops, electronic scrap or spent catalyst material
- … a world leader in the production of key materials for rechargeable batteries used in laptops and mobile phones
- Umicore's germanium substrates for high-efficiency solar cells are used in the bulk of the satellites launched today

Umicore today: global footprint

Umicore

	1999	2009
Revenues	€865m	€ 1,723.2m
Number of sites	32	85
Workforce	8,065	13,720

Where can Umicore play a role in Cleantech?

Less is More

Creating value by reducing the use of rare and valuable materials

Energy Solutions

Materials for energy storage and sustainable energy production

Recycling Solutions

Addressing resource scarcity and emissions by closing the materials loop

Environmental Solutions

Technologies to mitigate environmental impacts

Recycling solutions in Cleantech

	Product	Recycling
Germanium substrates (Space & CPV)	✓	✓
Automotive catalysts (PGM's)	✓	✓
ITO / AZO targets	✓	✓
Selenium, Indium, Tellurium, Gallium*	✓	✓
Rechargeable batteries	✓	✓
Electronics (contacts, solders…)	✓	✓
Platinum components and catalysts for glass industry	✓	✓
Jewelry precious metal alloys	✓	✓
Ag	✓	✓

* unrefined Ga product

Growth investments

Energy solutions > Rechargeable batteries

Li-Ion cathode materials

- Capacity & capability expansion in Cheonan, South Korea
- Completed

Cheonan

Li-Ion cathode precursors & materials

- Production plant in Jiangmen, China
- Completed

Jiangmen

Growth investments
Energy solutions > Photovoltaics

Germanium substrates for high-efficiency cells

- Production plant in Quapaw, US
- Plant constructed, under qualification

Quapaw

Rotary sputtering targets for thin film cells

- Development lab in Balzers, Liechtenstein and Providence, US

Recycling service for thin film cell production waste

- Recycling plant in Hoboken, Belgium

ITO rotary target

Growth investments
Recycling solutions

Jewellery and electroplating materials

- Recycling and production facility in Foshan, China
- Completed

Foshan

Battery recycling

- Pilot line in Hoboken, Belgium
- Initial investment of €25m approved

Umicore Special Metals

	**Tellurium**	Capacity: 150 t/y Quality: 2N5 Forms: powder, ingots
	**Indium**	Capacity: 50 t/y Quality: 4N, 4N8 Forms: ingots, shots, shells
	**Selenium**	Capacity: 600 t/y Quality: 2N5, 3N, 4N5, 5N, 5N+ Forms: powder, shots

Umicore Precious Metals Refining

Best available technology focussed on secondary precious metal materials

Feed: 350,000 mt complex PM materials

Recovered metal value (2007):
2,600 M$ PM, other metals 400 M$

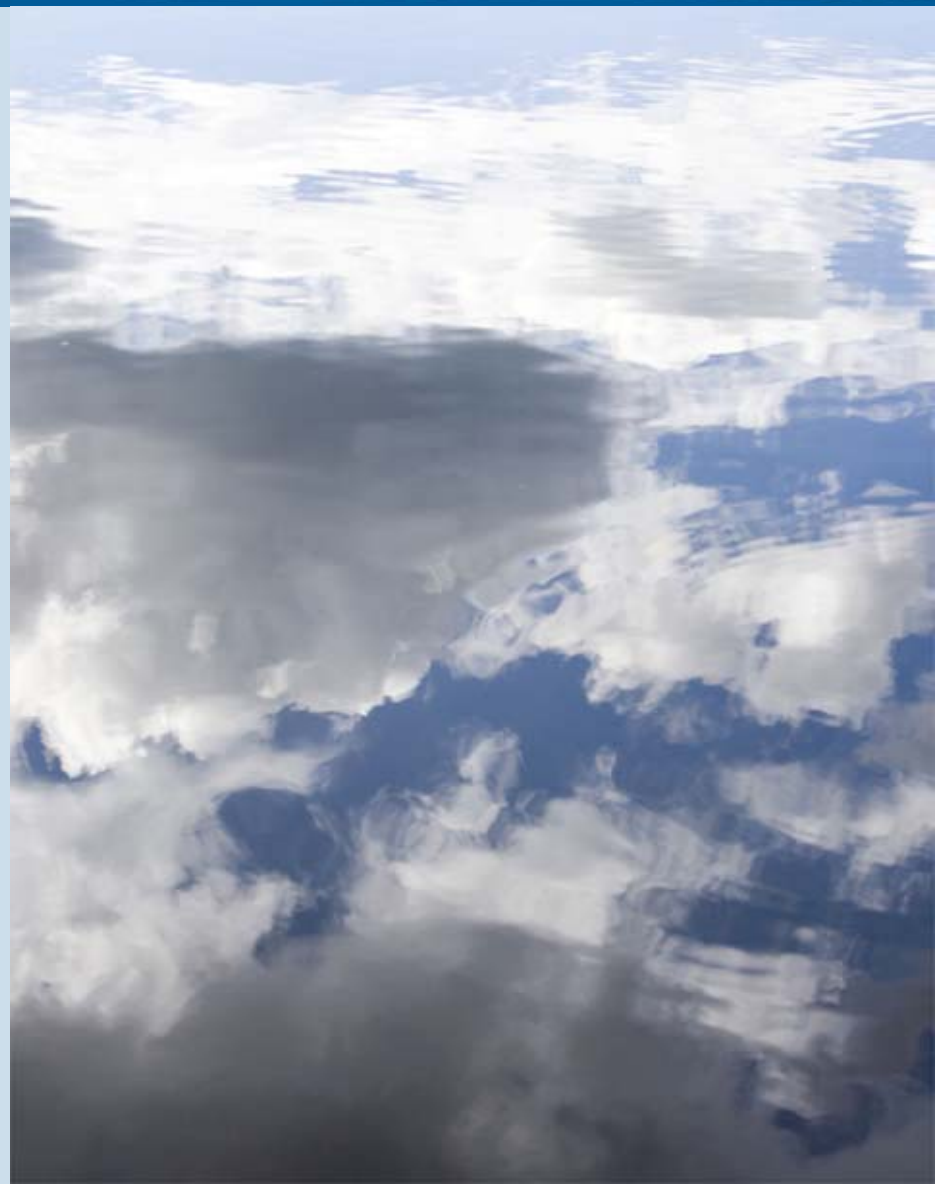
PM recovery yield > 95%

Highest environmental standards:
ISO 14001 & 9001, OSHAS 18001

Minimizing waste < 5%

> 1 billion € investment

II Why should we bother?

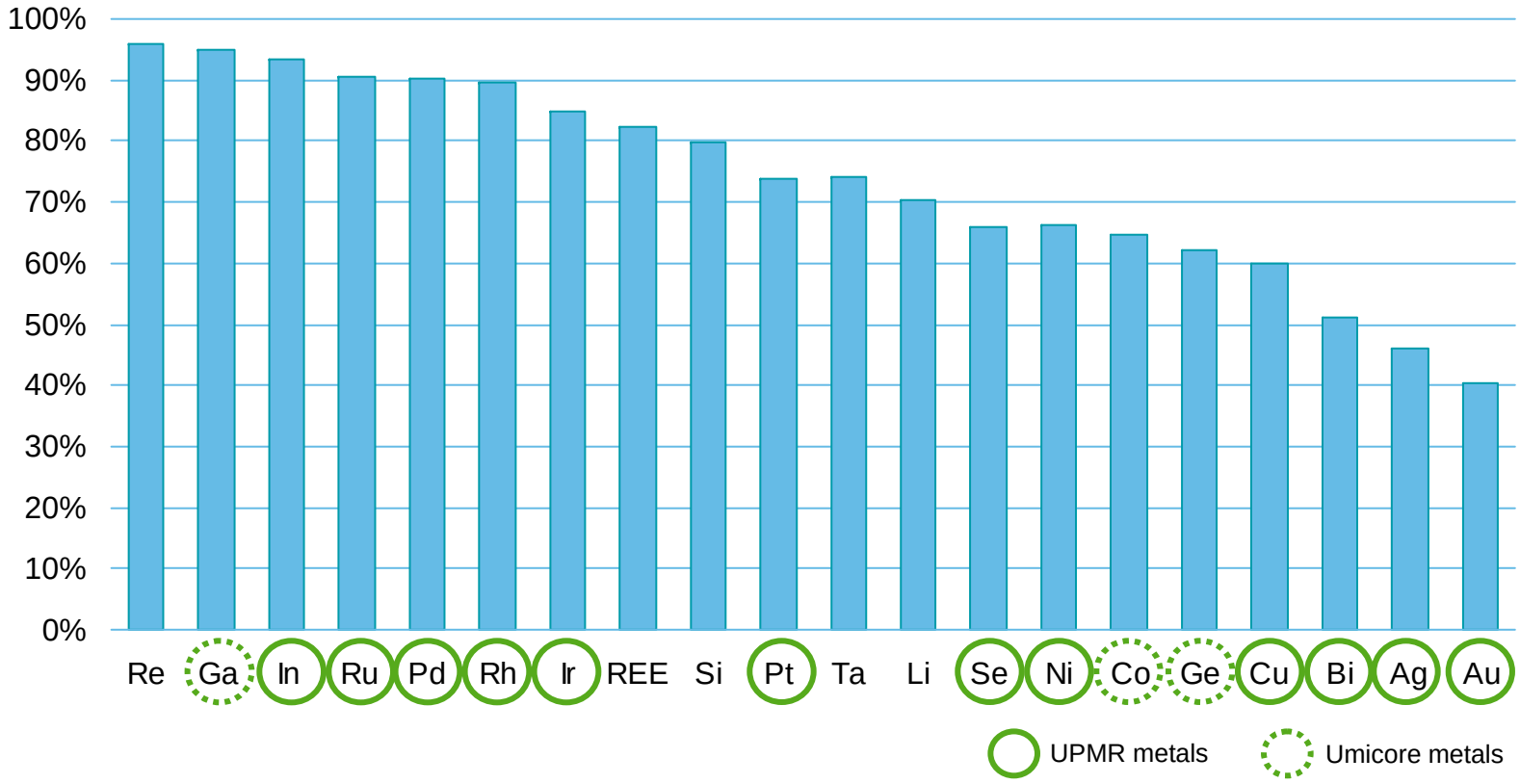


The very hungry caterpillar by Eric Carle

Are we behaving just like this caterpillar?

Increase in demand started 2-3 decades ago

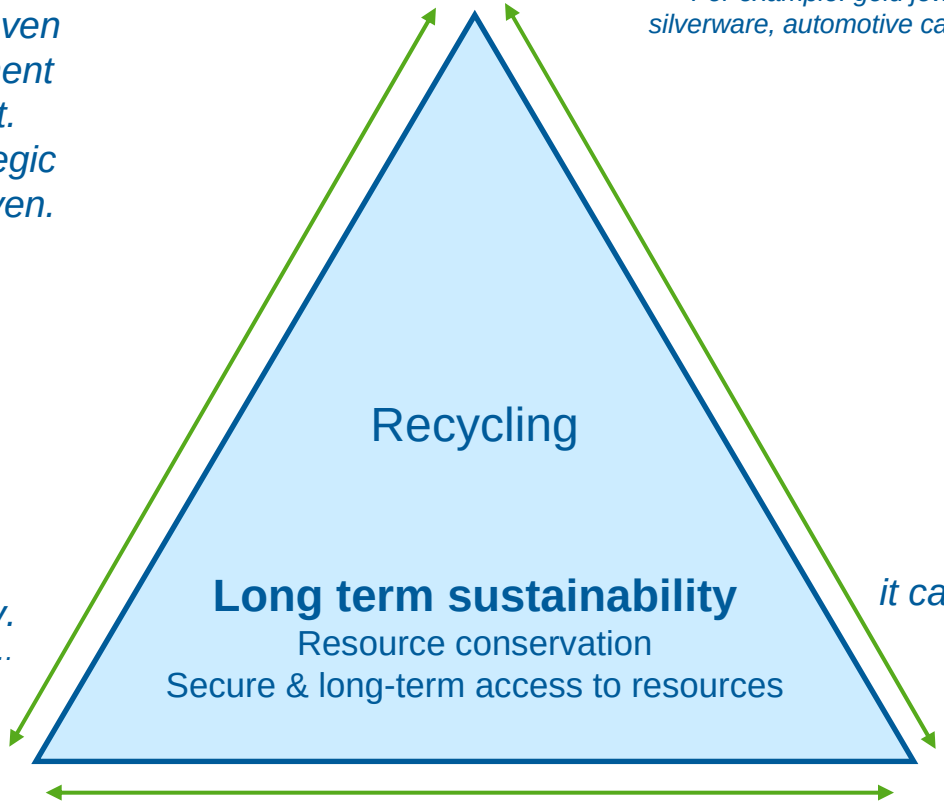
Mined in the last 30 years compared to mined since 1900 in %



Competing for the same metals

	In	Ga	Se	Te
Photovoltaics	✓	✓	✓	✓
Medical/dentistry	✓	✓	✓	✓
Magnets	✗	✗	✓	✓
Other alloys	✓	✗	✓	✓
Metallurgical	✗	✗	✓	✗
Glass, ceramics, pigments	✓	✗	✓	✓
Batteries	✓	✗	✗	✗
Catalysts	✗	✗	✓	✓
Nuclear	✓	✗	✗	✗
Solder	✓	✗	✗	✗
Electronic	✓	✓	✗	✓
Opto-electric	✓	✓	✓	✓
Grease, lubrication	✗	✓	✗	✗

Drivers for recycling



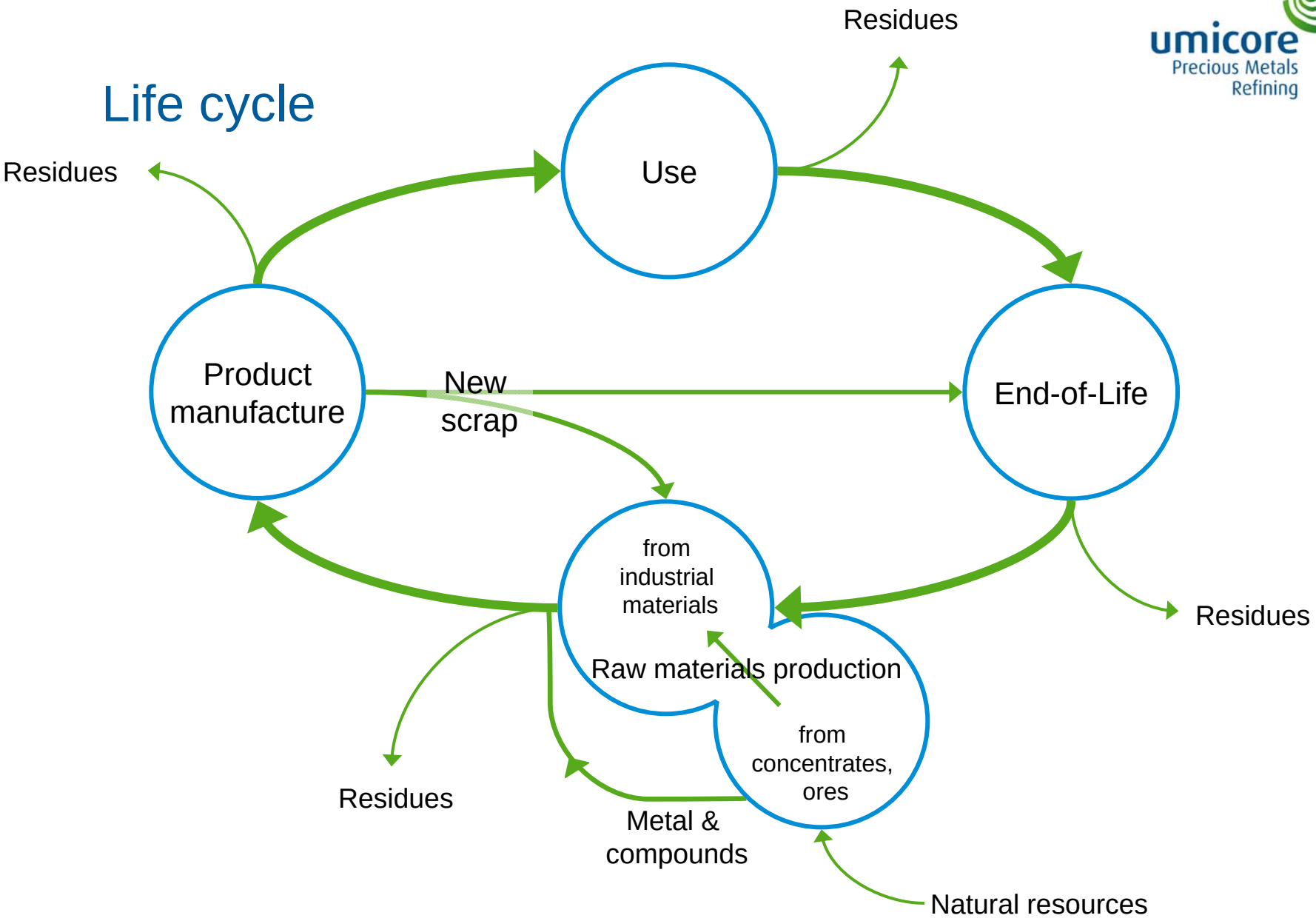
III Challenges in closing the loop

a primary supply

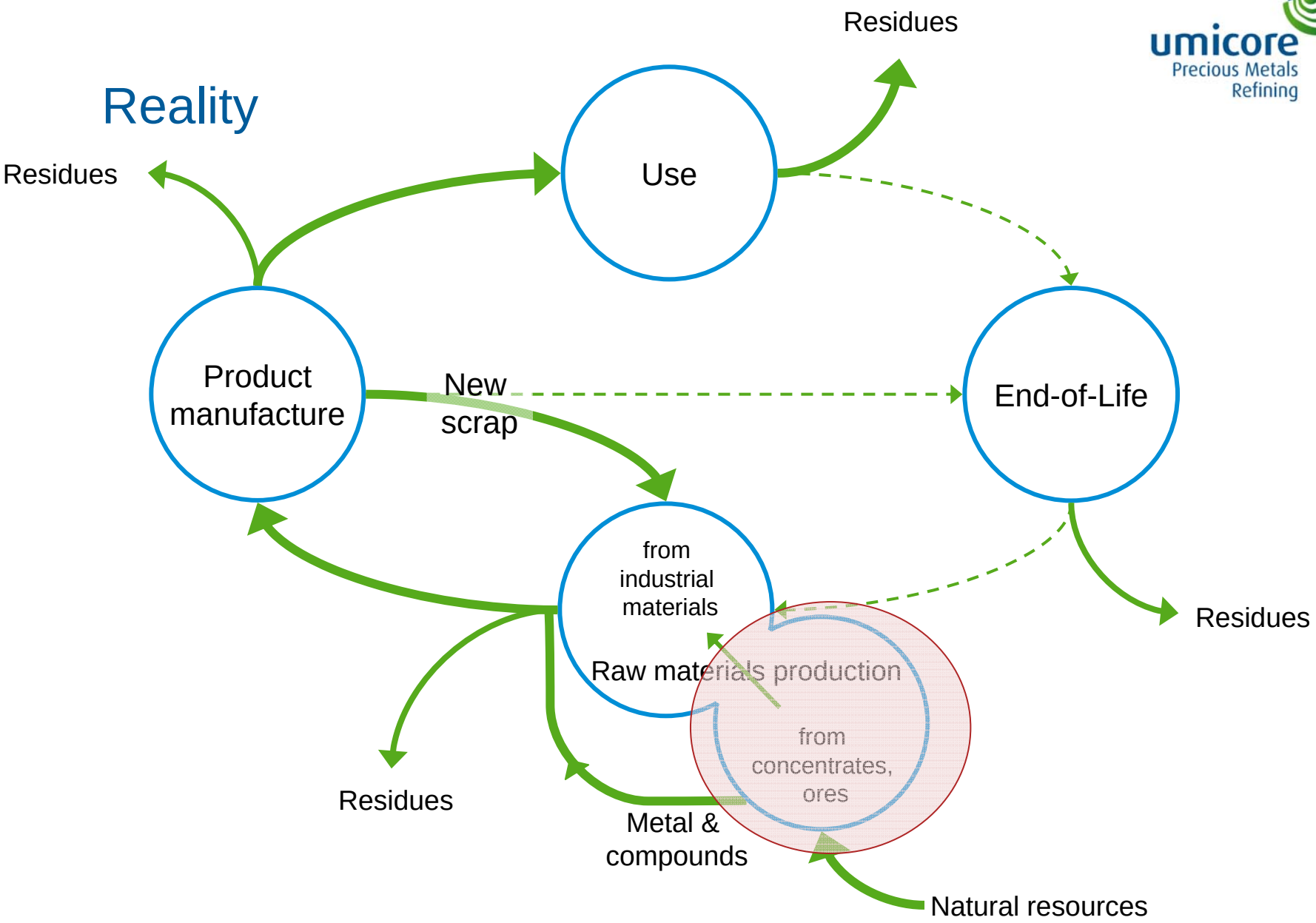
b ITO recycling

c CIGS recycling

Life cycle


Residues
Use
Residues
Product manufacture
New scrap
End-of-Life
from industrial materials
Raw materials production
Residues
from concentrates, ores
Residues
Metal & compounds
Natural resources

Reality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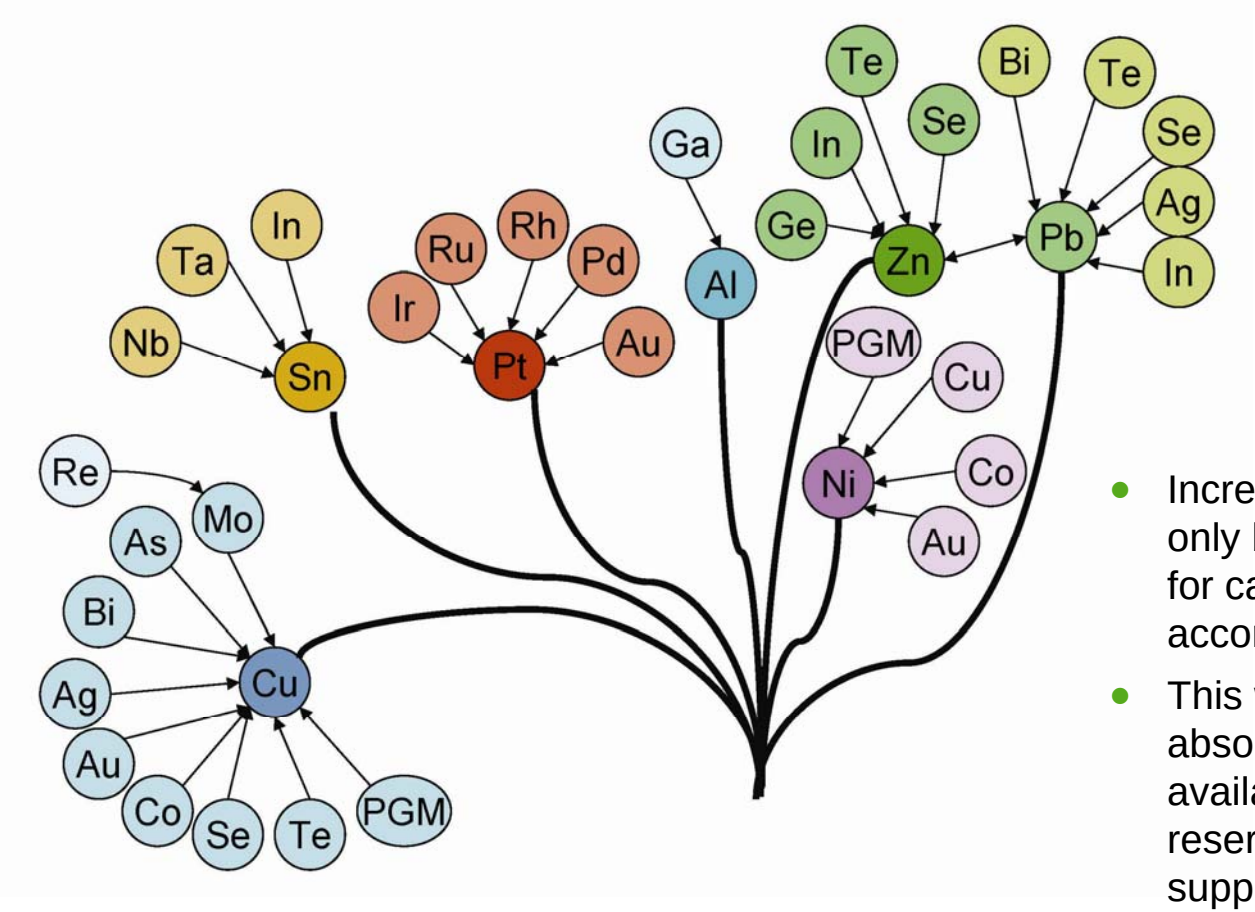
Coupled production affects primary supply

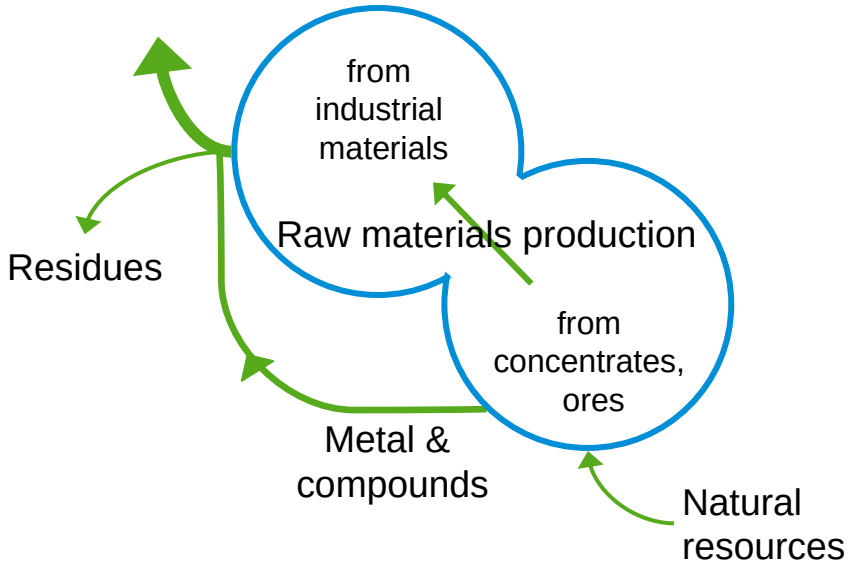


- Increased demand can only be met if demand for carrier metals rises accordingly
- This will place an absolute cap on total availability in terms of reserves and primary supply

C. Hagelüken, CEM Meskers: Complex life cycles of precious and special metals *in* Linkages of Sustainability. T Graedel and E van der Voet (eds), 2010

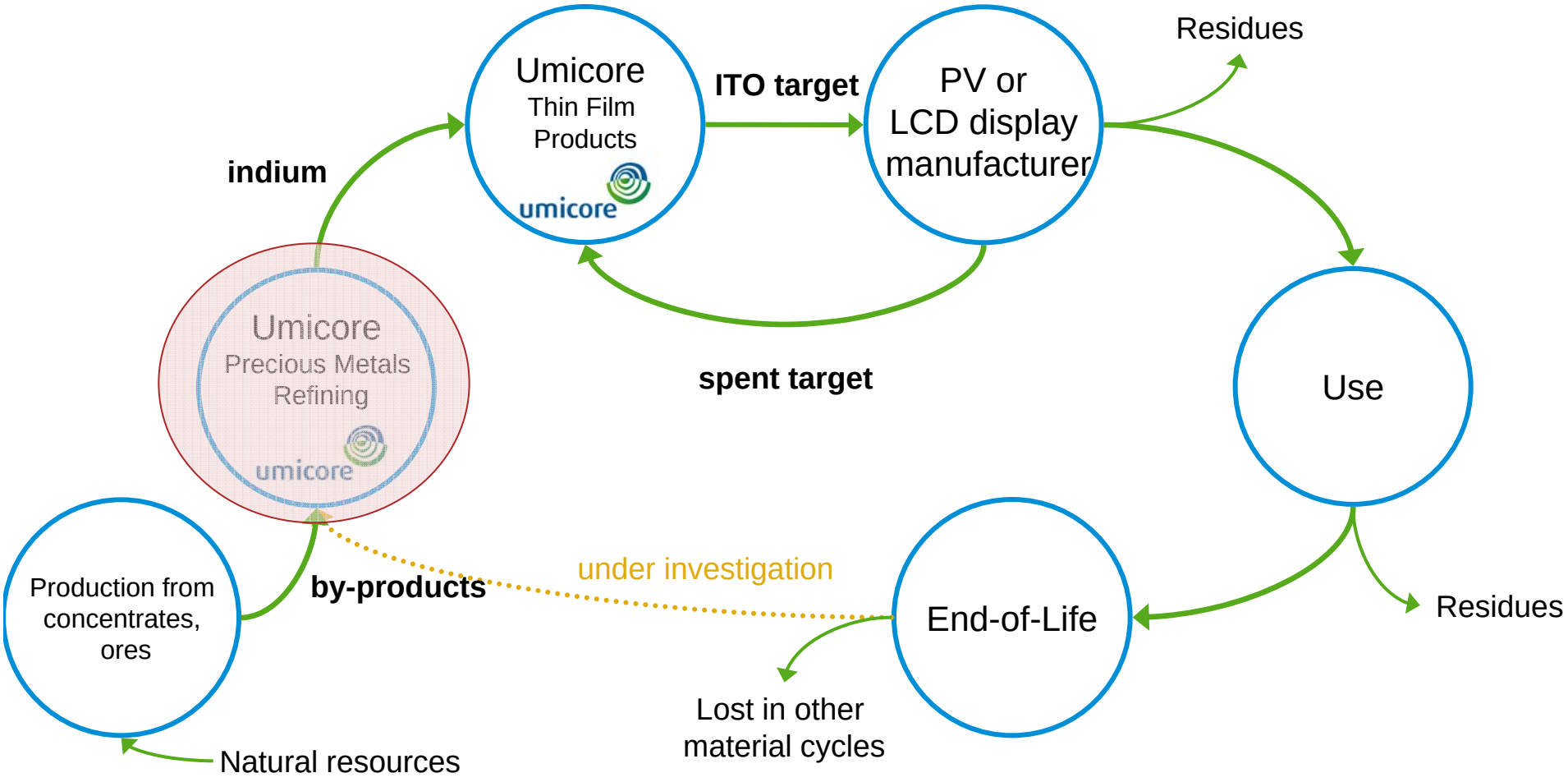
Challenges in primary supply

1. Mining
   - Production of special metals is coupled.
   - Losses in tailings
2. Smelting
   - Losses in parent metal, slag, other residues.
   - Smelter has to be equipped for effective special metal recovery OR
   - By-products of smelter are sent to specialized treatment facility for recovery of precious & special metals ⇨ Umicore
3. Refining
   - Logistics and refining processes will affect availability of high purity minor metals

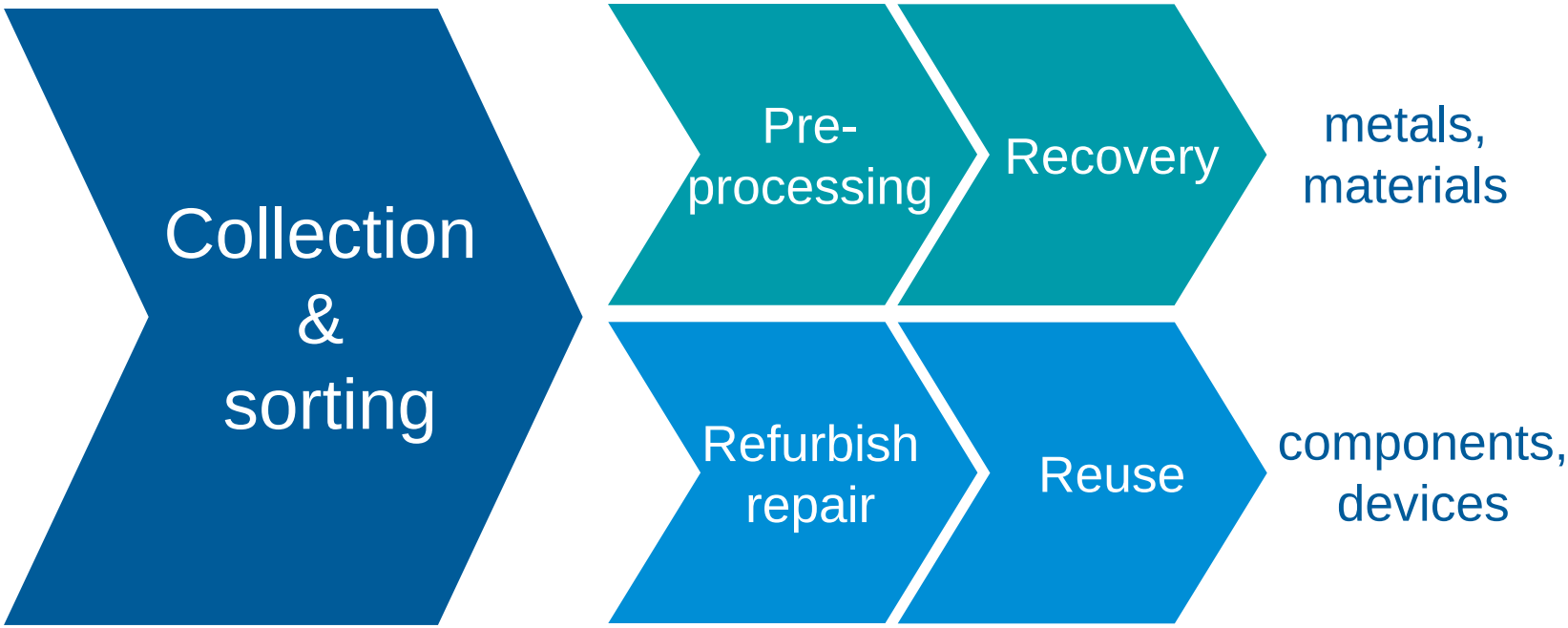


Indium Tin Oxide recycling

Indium Tin Oxide



Stages in the recycling of complex goods



The main objective of pre-processing is to effectively and efficiently separate the goods to be recycled into fractions that can enter existing and sustainable mainstream recovery processes.

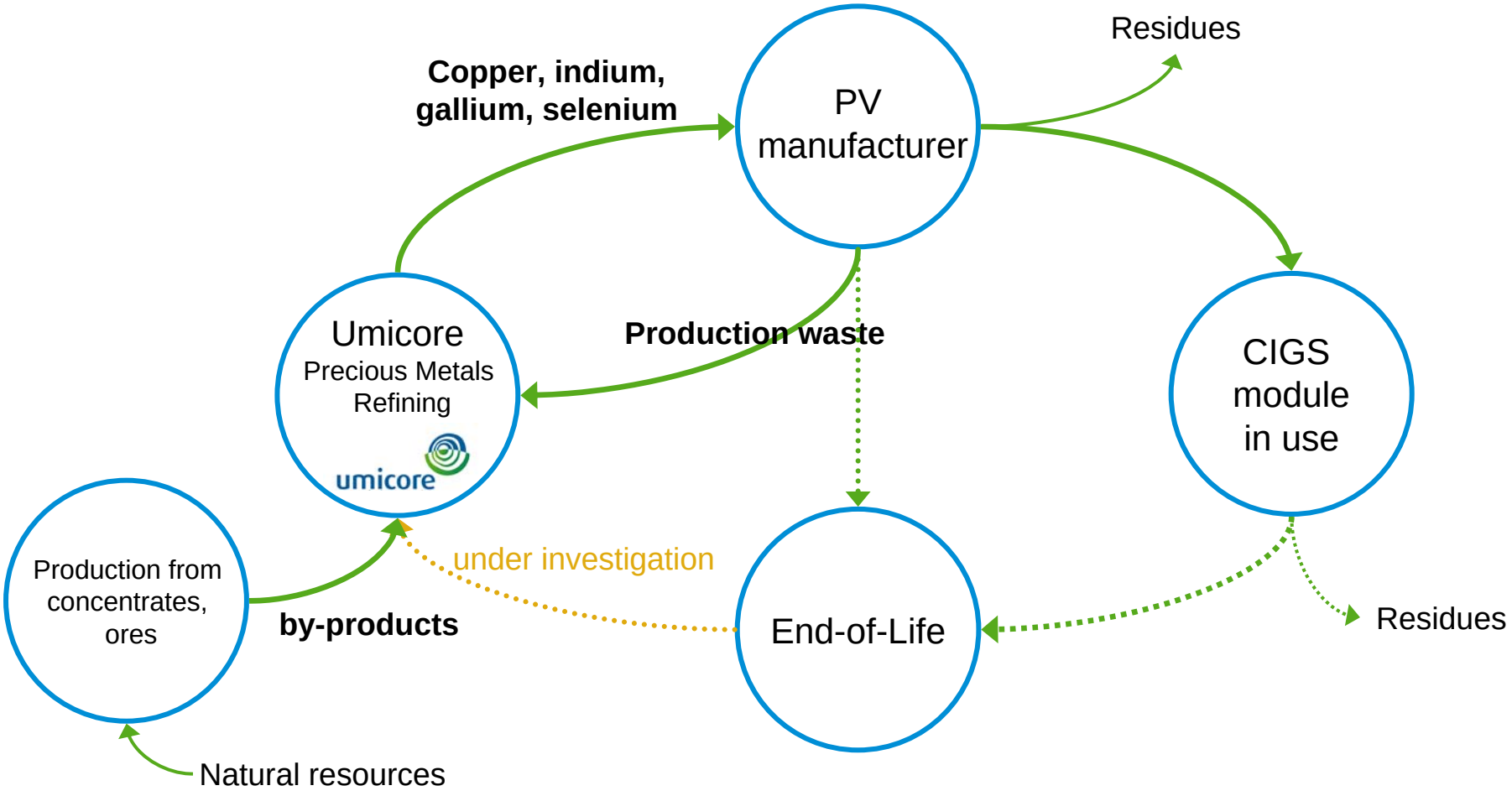
Challenges in the ITO cycle

- Indium is supplied via processing of by-products of the non-ferrous industry
- Indium is used for the production of ITO targets
- Spent targets are recycled into targets

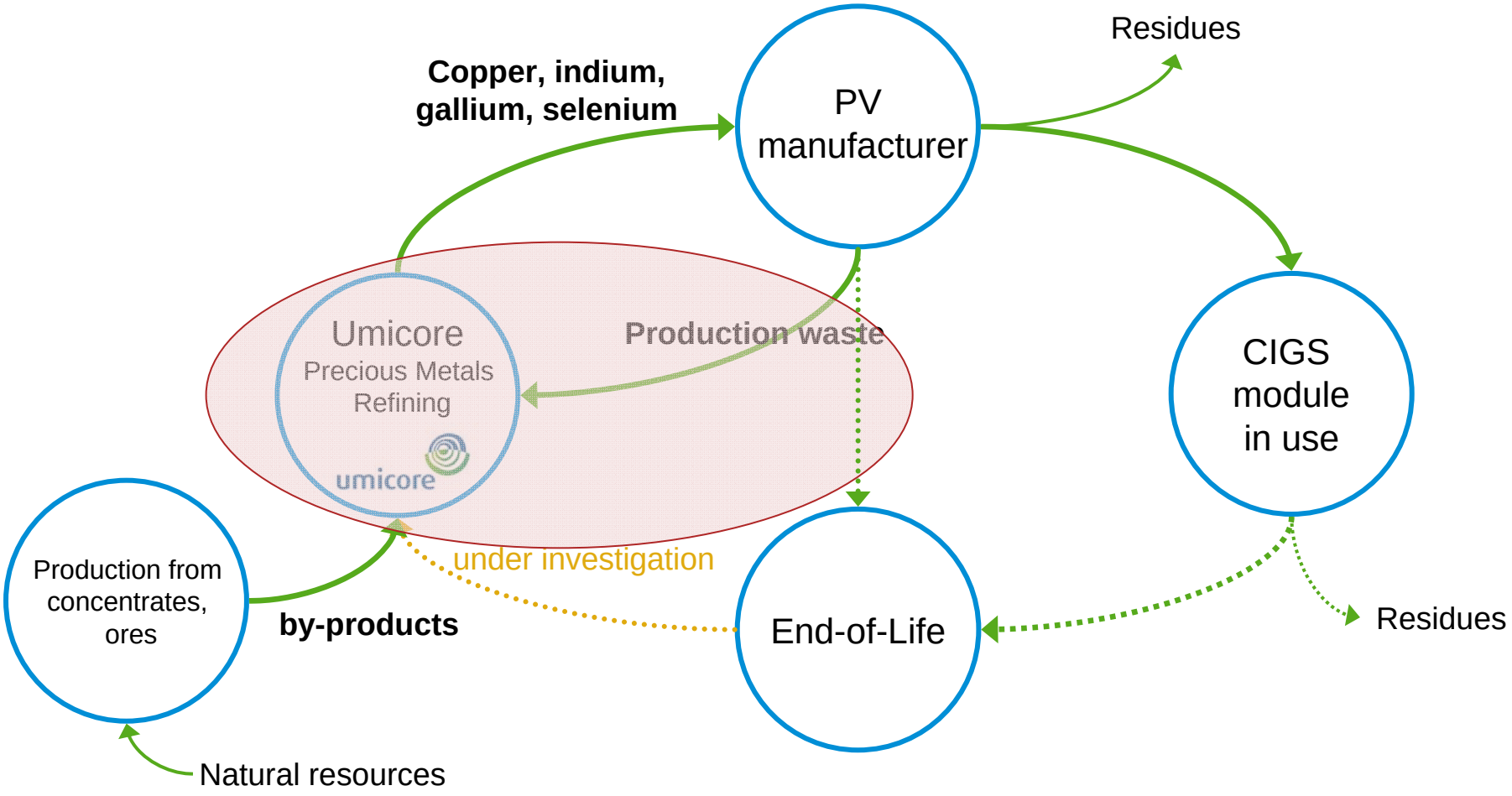
1. Manufacturer
   - Losses of indium in other waste or residue streams
   - Recycling of targets works well because of their value
2. End-of-Life product recycling
   - Small products with LCD display are very difficult to collect
   - EU WEEE directive pushes recycling of LCD display
   - Dismantling & separation technology is recently developed, off the shelf not possible due to Hg in backlights
   - Umicore's role in recycling In-containing fractions under investigation

CIGS recycling

CIGS


Copper, indium, gallium, selenium
PV manufacturer
Residues
Umicore Precious Metals Refining
Production waste
CIGS module in use
Production from concentrates, ores
by-products
under investigation
End-of-Life
Residues
Natural resources

CIGS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Natural resources

CIGS production waste recycling

Challenges in the CIGS cycle

Production wastes

- Umicore has closed the cycle for production wastes from sputtering and evaporation chambers
- Cu, In, Ga and Se are recovered for use in the PV or other industries

End-of-Life product recycling

- End-of-life products are hardly available
  - CIGS is a new technology and product life time is long
- Recycling driver is likely to be “volume” combined with a societal need
- Technologies for End of Life and recycling are under development
- Appropriate business models need to be developed too

Closing remarks

- Vision burden ⇨ opportunity
  ⇨*new business models to increase collection*
- Attitude waste management ⇨ resource management
  ⇨ *comprehensive collection plus stop of dubious "waste" exports*
- Objective focus on mass ⇨ focus on quality and specific substances
  ⇨ *system approach and prioritisation*
- Practice traditional business ⇨ high-tech recycling
  ⇨ *recycling is a clean future technology so adapt structures accordingly*

**For future technologies (PV, EV/HEV, FC, …)
recycling strategies need to be developed at an early stage!**

Thank you

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