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SUSTAINABLE INORGANIC MATERIALS MANAGEMENT

PROTECTING ENDANGERED ELEMENTS

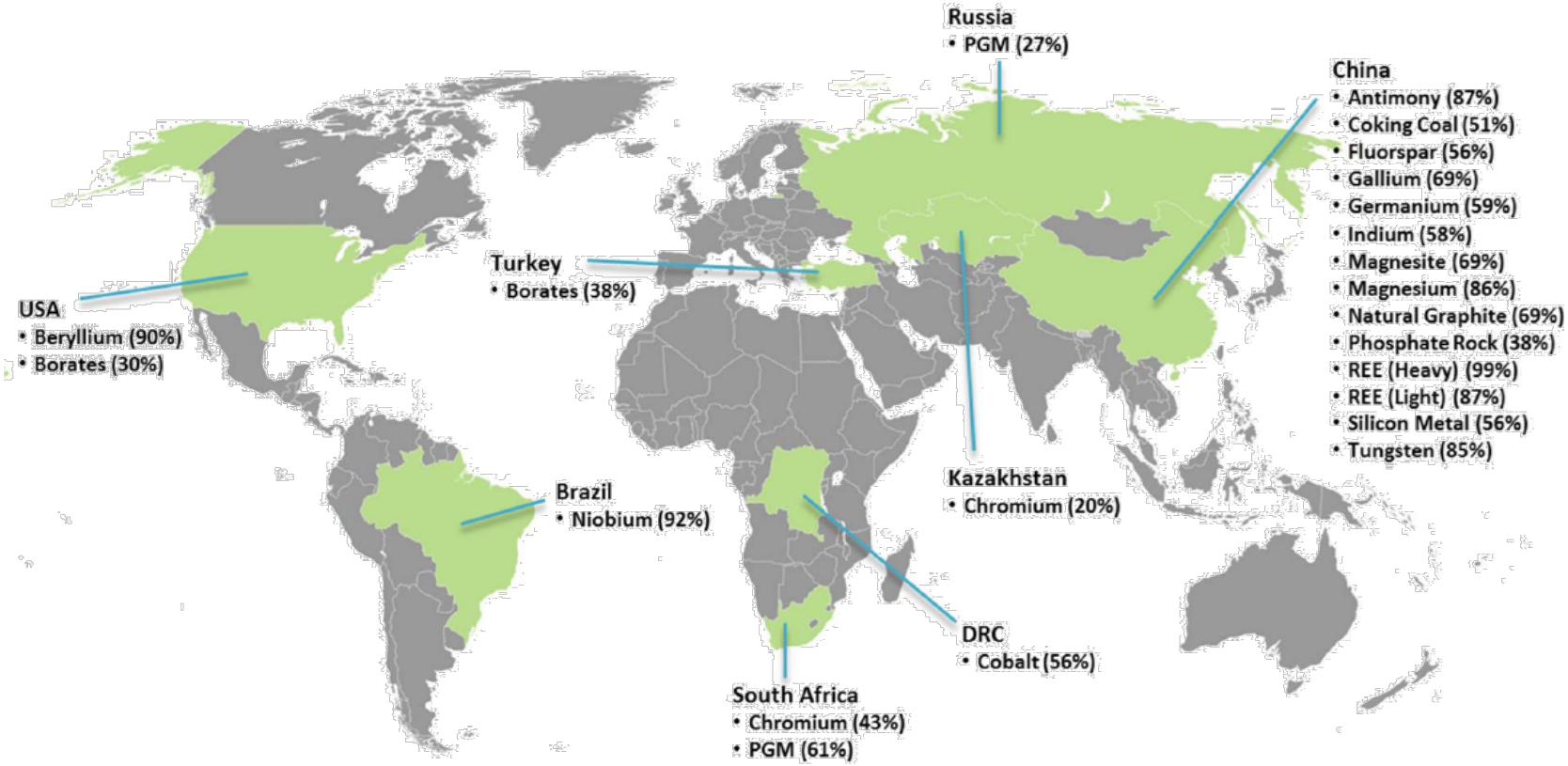
EuCheMS European Chemical Sciences

Towards zero-waste valorisation of fresh and landfilled wastes and residues

Dr Ir. Peter Tom Jones & Prof. Koen Binnemans,
SIM² KU Leuven

22 September 2015, EuCheMS, Brussels

Raw material supply faces major challenges: "*Europe, the poorest continent in the world*"



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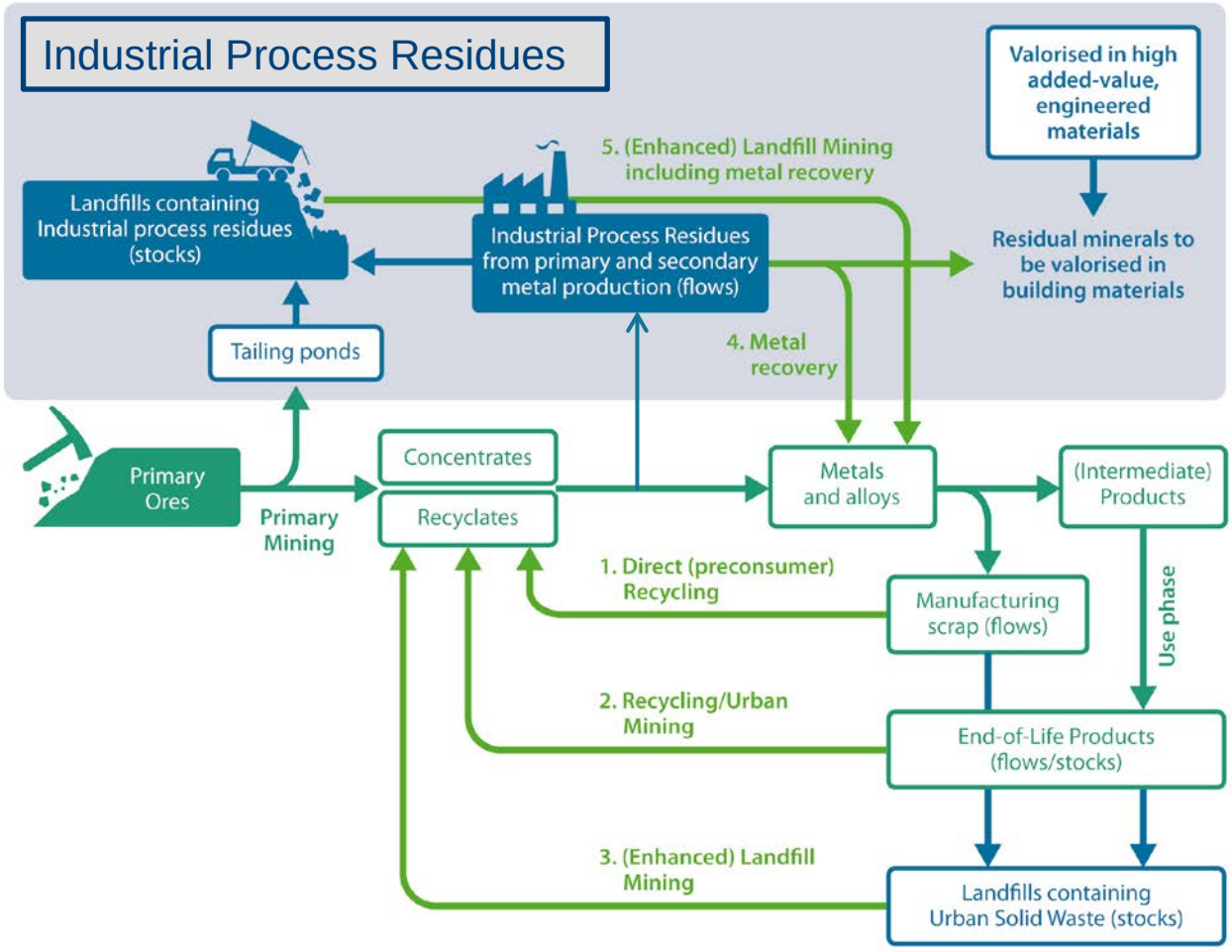
EU therefore needs to excel in substitution and recycling - From urban to landfill mining:

1. *End-of-Life products*
2. *Enhanced Landfill Mining*
3. *Secondary resources*

SIM² KU Leuven Philosophy: Closing the loop through urban & landfill mining



K. Binnemans, P.T. Jones, et al., *Journal of Cleaner Production*, 2015

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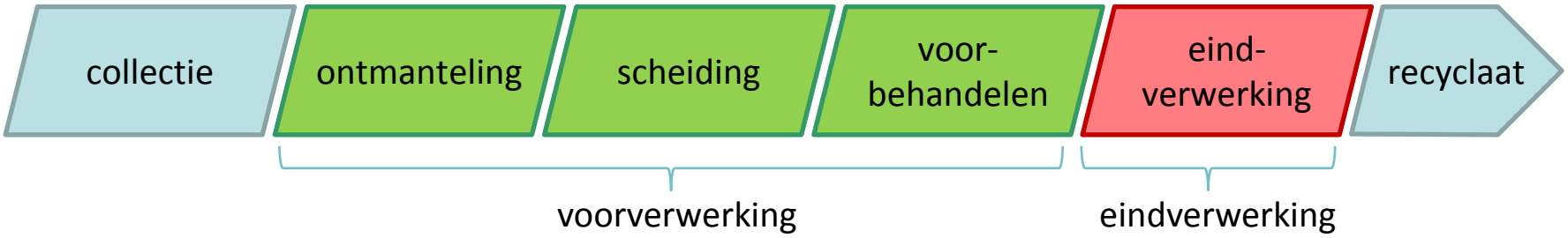
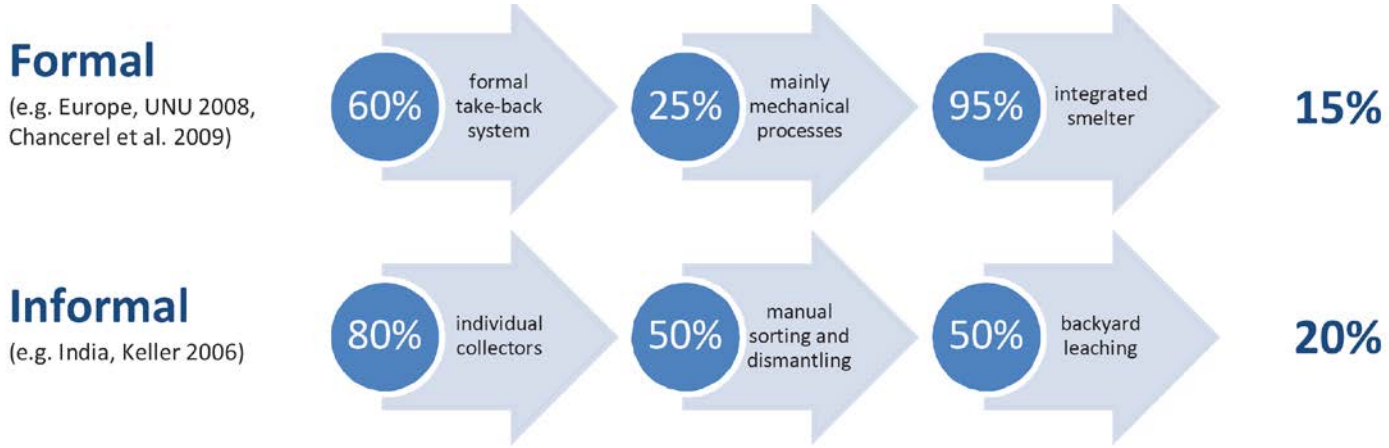
1. EoL products: Efficient recycling/urban mining requires holistic approach





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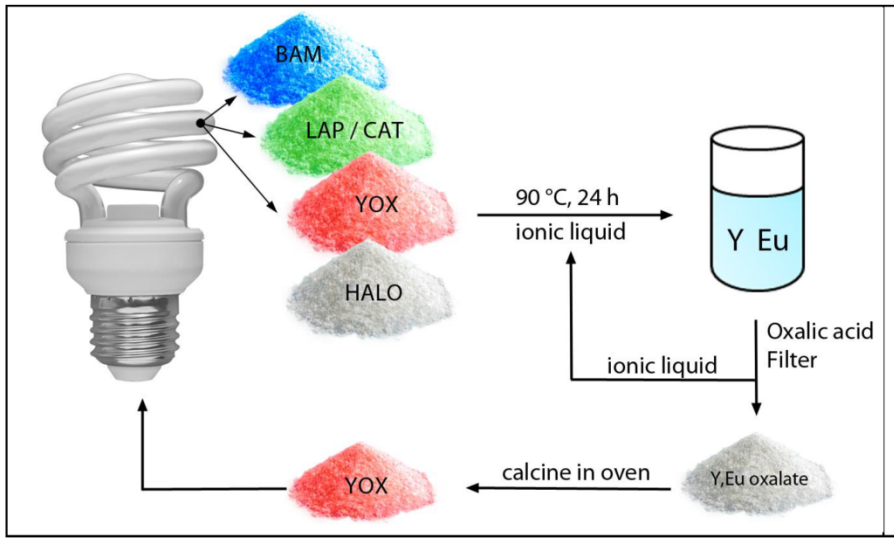
Example: Selectieve recuperation of Eu and Y from End-of-Life CFLs (using ionometallurgy)



Key advantages:

- Selective dissolution of $Y_2O_3:Eu^{3+}$ (70% of the total value in the powders)
- Regeneration of new red YOX phosphor
- Short 3-step process
- Very basic chemical operations (no purification or solvent extraction)
- Only oxalic acid is consumed (stoichiometric amounts to make YOX)
- Zero (additional) waste generation (except CO_2)
- Mild conditions (< 100 °C, pH > 1)

D. Dupont and K. Binnemans, *Green Chemistry* **17**, 856–868 (2015) + front cover

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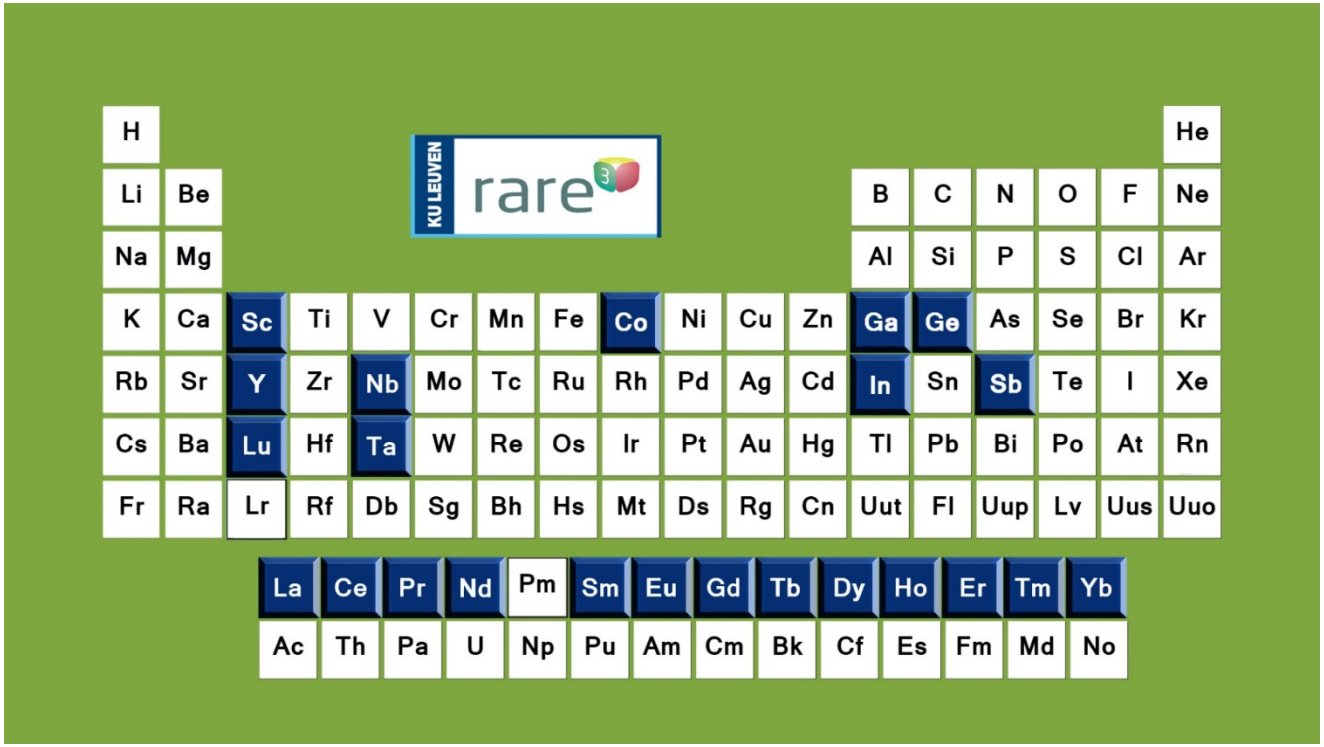
SIM² KU Leuven covers more than REEs – strong focus also on Sb, In, Ge etc.



Processing of critical metals is a technological challenge

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2. Enhanced Landfill Mining

[of MSW/industrial residue landfills]

- 150,000 - 500,000 landfills in Europe
  - From MSW, mixed to industrial landfills
  - From waste dumps to state-of-the-art landfills
- Do-nothing scenario is not an option
  - Remediation costs for EU-28 projected to be 0,1-1 trillion euro in the next 5 decades
- ELFM targets recovery of metals, materials, energy and land) & preserves drinking water
- Prioritisation is required: remediation need, content, location and size are key parameters

EURELCO

European Parliament

Enhanced Landfill Mining Seminar
20-10-2015

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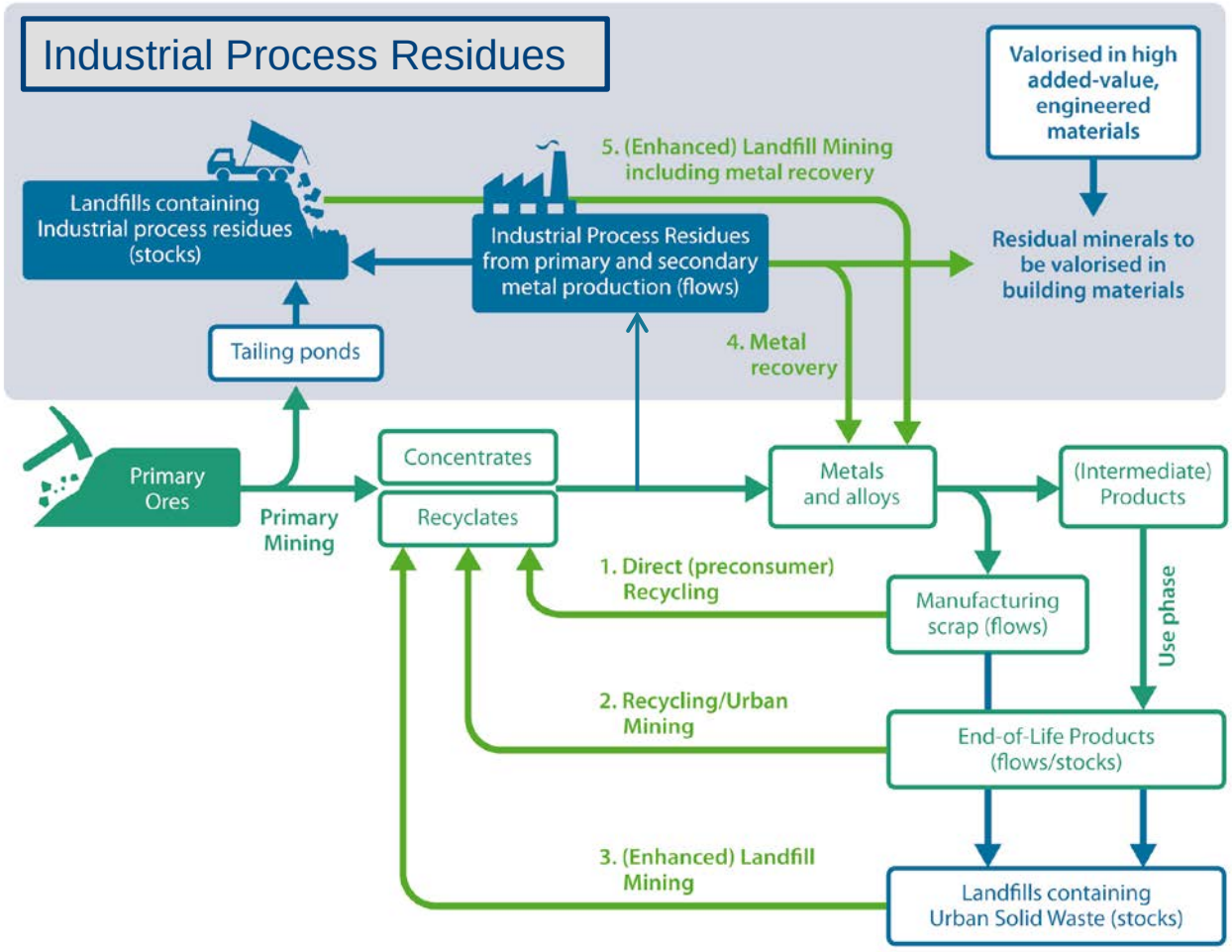
3. Industrial Process Residues (fresh/landfilled flows/stocks)



Zero-waste valorisation principle!

K. Binnemans et al., *Journal of Cleaner Production*, 2015

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Flemish MaRes Programme:
Materials from Secondary Resources

- Flanders has no primary ores containing critical metals
- BUT… Flanders has:
  - Large volumes of **secondary (industrial) process residues**: tailings, sludges, slags and ashes (e.g. phosphogypsum, goethite)
  - Leading metallurgical companies and research institutes

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MaRes Rationale: metals and minerals from residues - towards new metallurgical systems

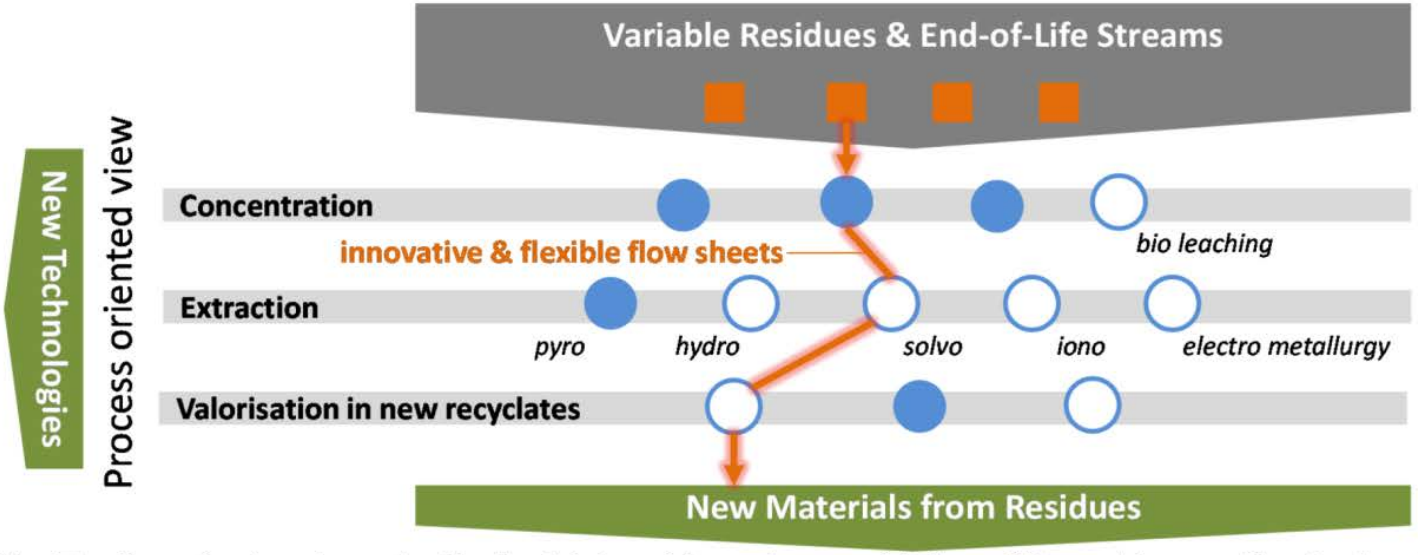

Fig. C5 - Toolbox for treatment of industrial residues by combining different innovative technologies

MaRes aims at creating and demonstrating an operational, flexible toolbox combining pyro-, hydro-, electro-, bio-, solvo- and ionometallurgy technologies to recover metals and to hot stage engineer and valorise the residual matrix into highly innovative low-carbon building materials and other mineral materials.

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MaRes Roadmap Flanders: binders from secondary resources (case: MetalloChimique)

Table produced from cleaned fayalitic slag (97% slag in product)

IWT O&O COZIRAS
MetalloChimique & KU Leuven → 36 M€ investment in new fumer to clean fayalite slag → new binders)

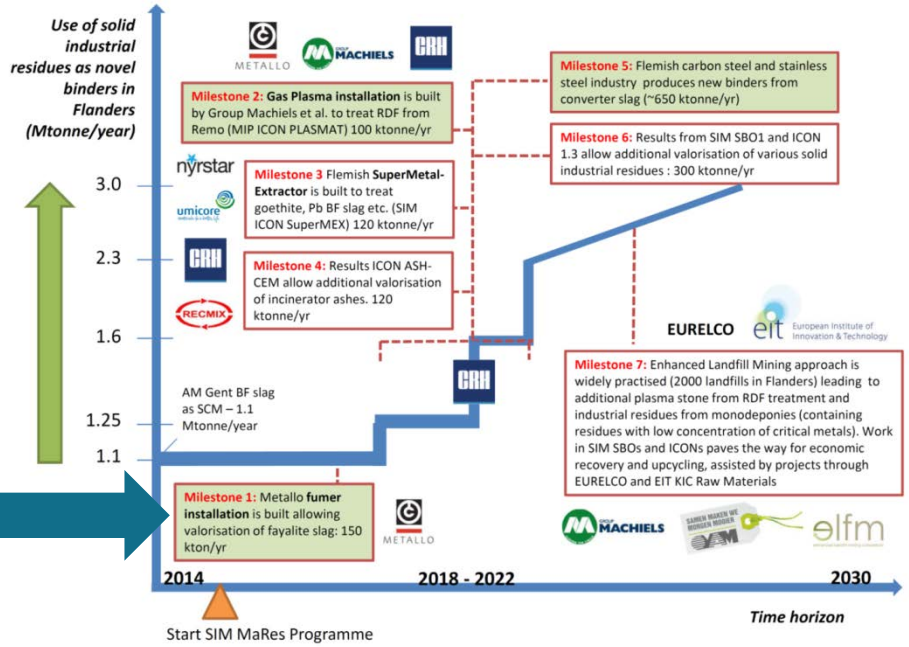

Fig. E2 – Industrial roadmap for Flanders with respect to production of OPC-replacing, low-carbon binders from freshly produced and stockpiled residues.

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MaRes ICON SUPERMEX project:
valorising CM containing sludges (Nyrstar) and slags (Umicore) with mineral valorisation into geopolymers (CRH) (KU Leuven)

Nyrstar Balen/Overpelt – Belgium

Composition Nyrstar's goethite sludge	Fe (wt%)	SiO_2 (wt%)	CaO (wt%)	Zn (wt%)	Pb (wt%)	In (g/t, dry basis)	Ge (g/t, dry basis)	Other elements
Freshly produced (80,000 tonnes/year)	24-36	3.7-8.4	0.7-6.1	5.9-12.9	1.5-3.7	100-500	50-100	S, Ag, As, Tl, Cd, Cu, Mn,..
Stockpiled goethite (> 1 million tonnes)	24-36	3.7-8.4	0.7-6.1	5.9-12.9	1.5-3.7	100-900	50-180	S, Ag, As, Tl, Cd, Cu, Mn,..

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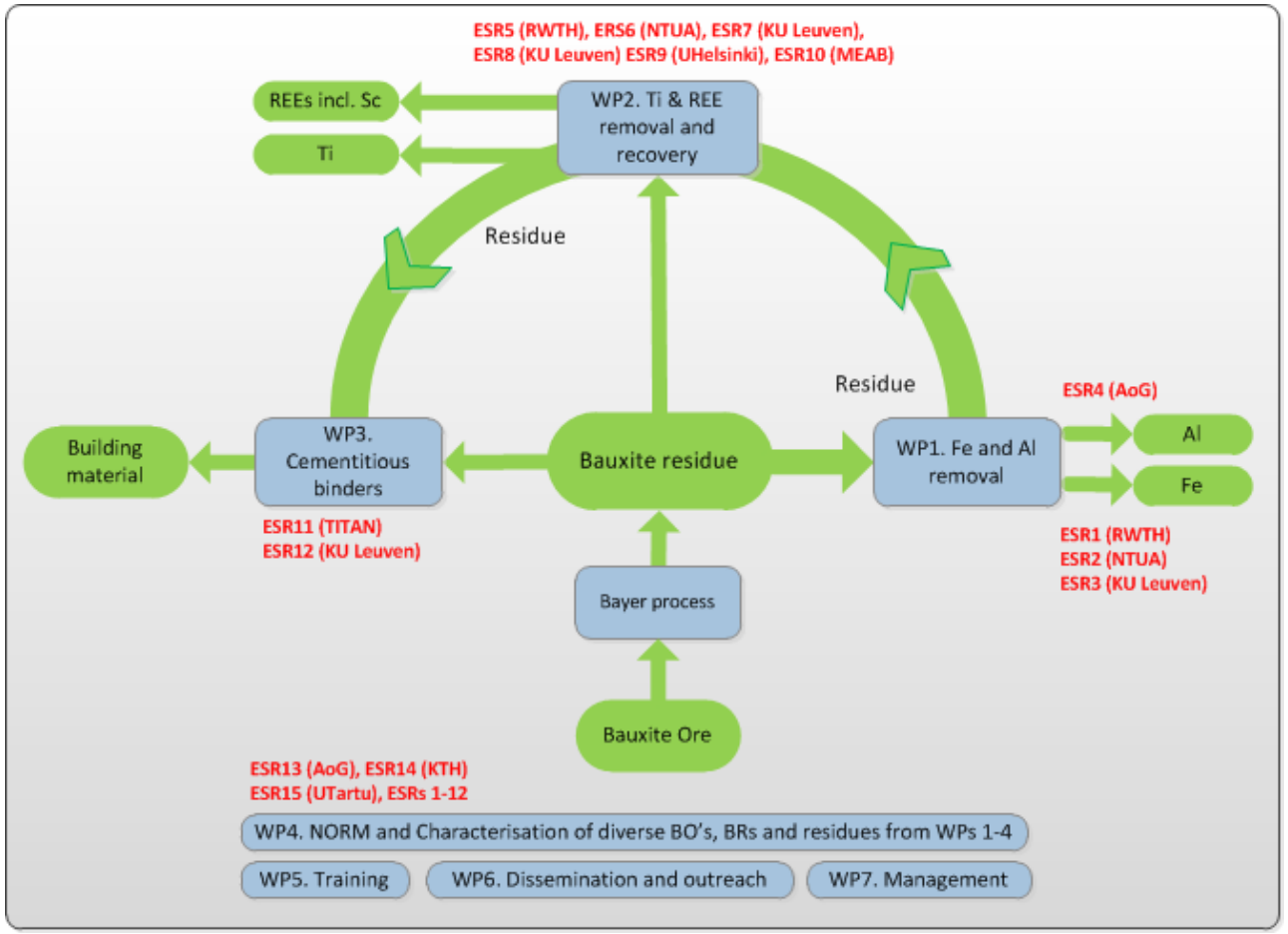
KU Leuven & Flemish cooperation on the EU level: a world to win!

Flagship KU Leuven project: H2020 MSCA-ETN REDMUD: zero-waste valorisation bauxite residue



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Pan-European collaboration to develop and implement the “New metallurgical system” toolbox

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FL

SIM innovating together

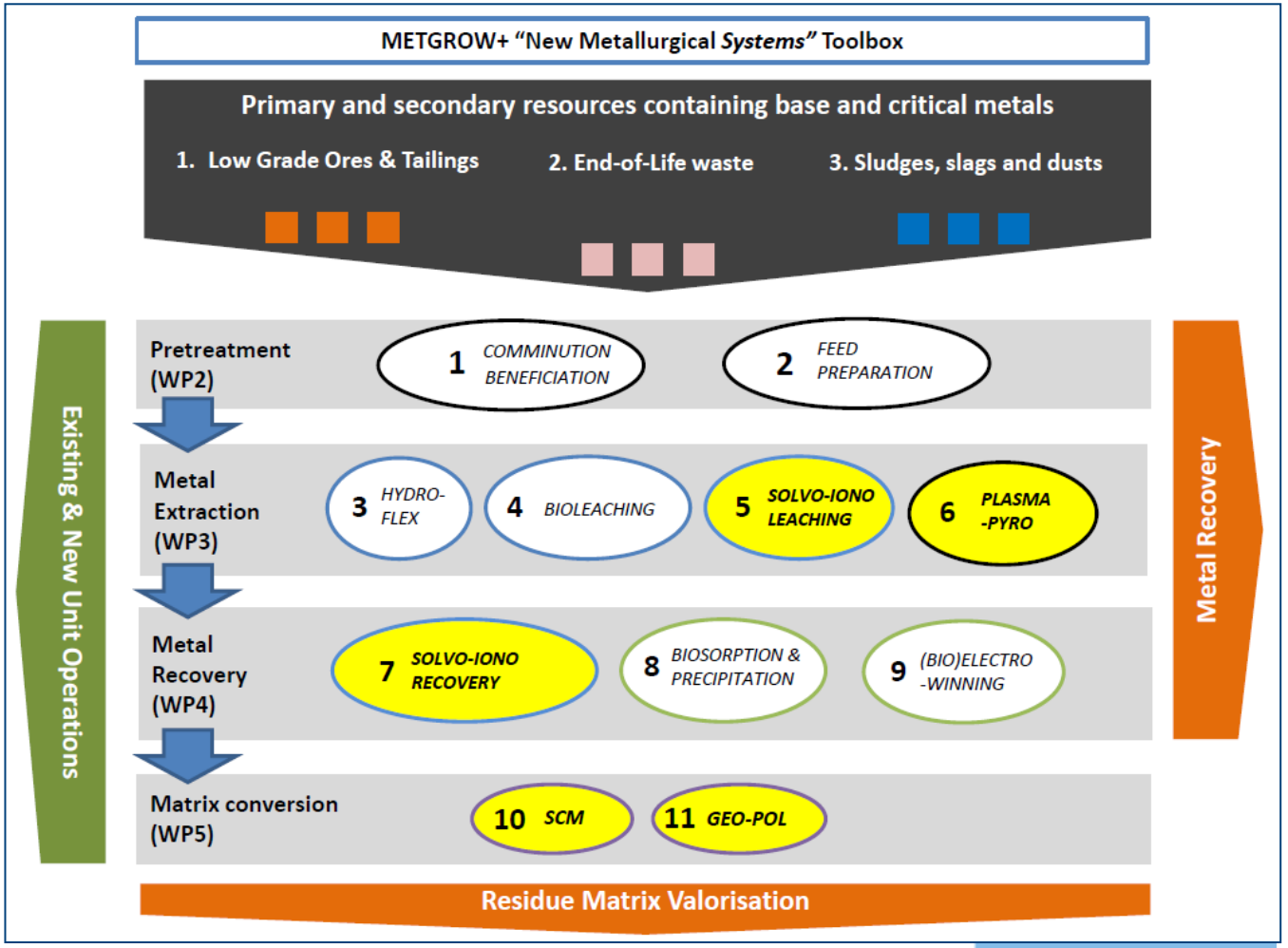
MaRes

EU

EU MSCA-ETN REDMUD

H2020 METGROW+

eit RawMaterials



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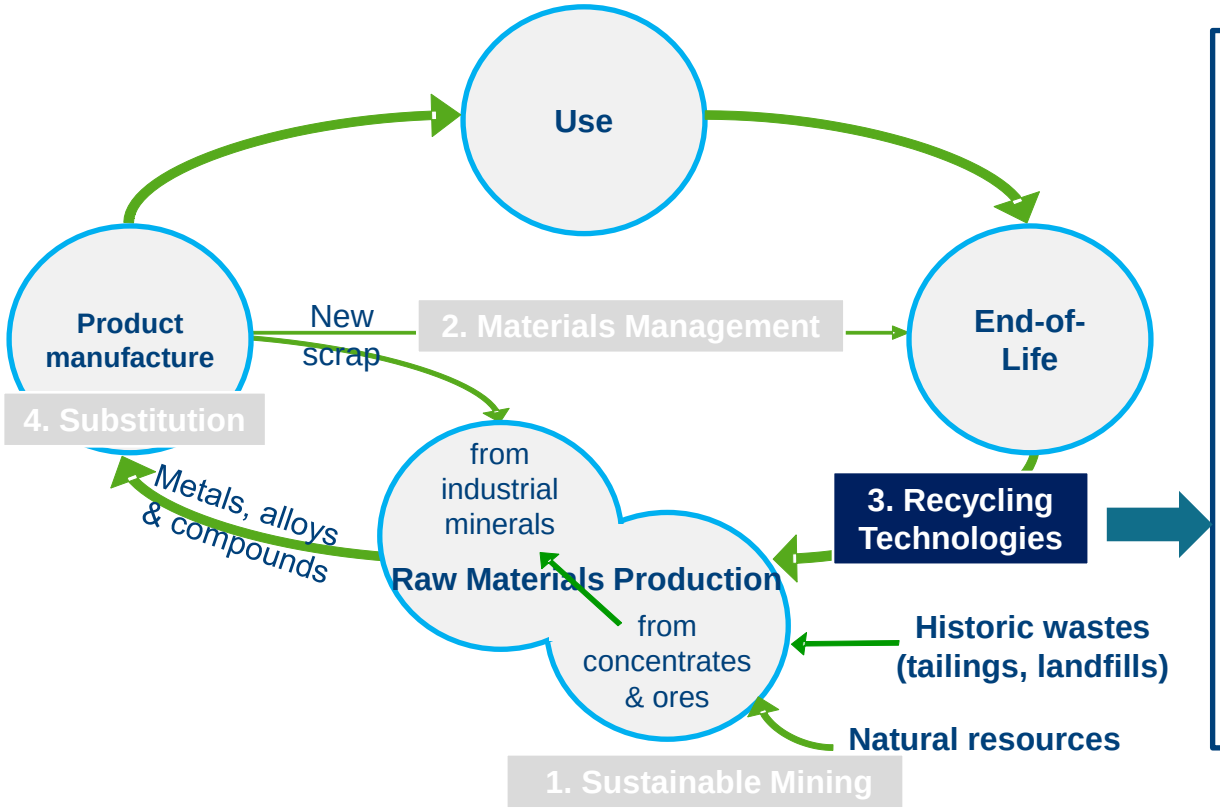
Circular economy and KU Leuven-Belgian participation in EIT KIC Raw Materials



Co-location centre "West" in Leuven

Belgian core partners:

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UNIVERSITEIT GENT

vito vision on tec

umicore

Université de Liège

CRM GROUP CRM

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