



# CIRCULAR ECONOMY AND CHEMISTRY

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# Today`s themes

- Robotics (*material handling, waste sorting*)
- Health and clean technology (*resource efficiency, information technology, recycling, pure water etc.*)
- Energy and clean technology (*wind and solar energy, energy storage, battery technology*)
- Food and agriculture & soil (*avoid of generating climate emissions and waste, nutrient cycle, secondary sources of phosforus*)



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# Circular economy and chemistry

- Concern about the availability of critical raw materials
- According to EU recycling is an important source of secondary raw materials (SRMs) (*JRC Report: Critical raw materials and the circular economy*)
- Special attention has been paid to the recycling rate of CRMs
- Demand for CRMs is growing in various sectors and recycling contribution is largely insufficient
- Need for new innovative technologies



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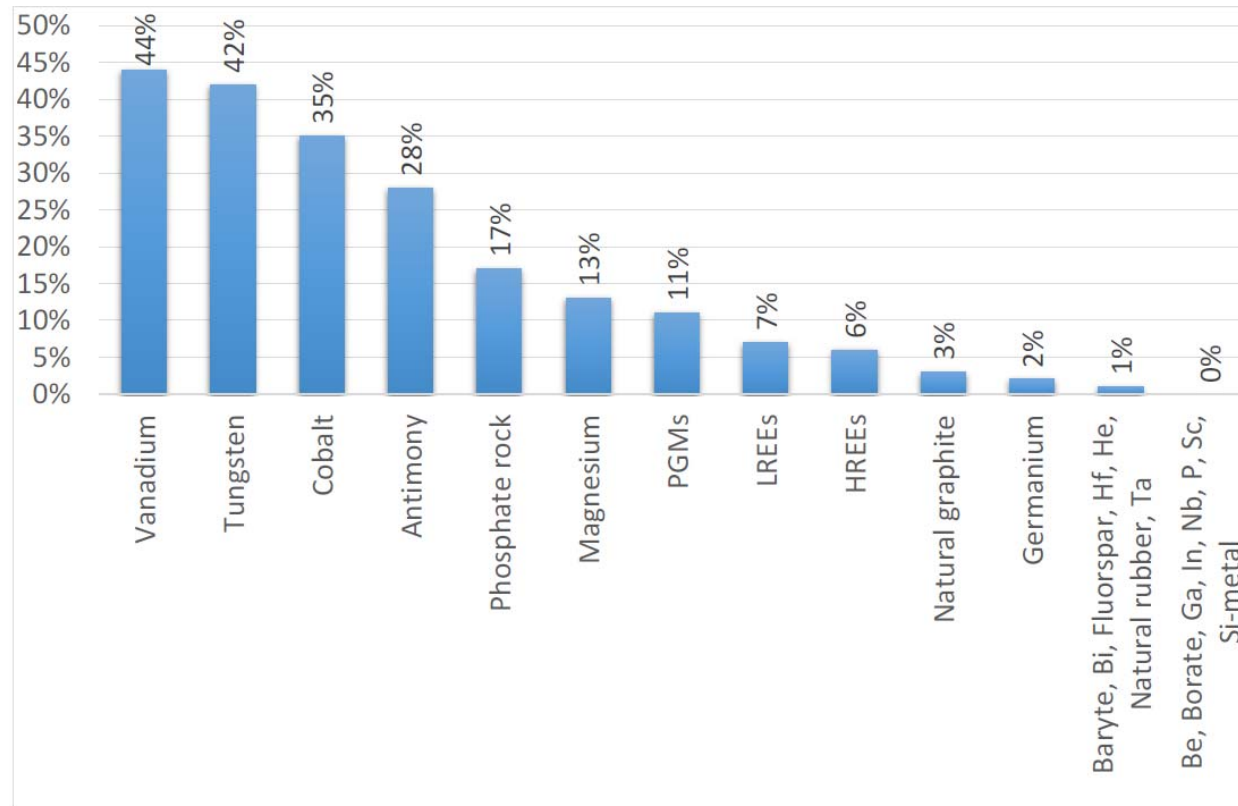


Figure 1. Current contribution of recycling to meet EU demand of CRMs: end-of-life recycling Input Rate (EOL-RIR). *Source:* JRC elaboration based on (Deloitte Sustainability, 2015) and (Deloitte Sustainability et al., 2017)).

<https://ec.europa.eu/jrc/en/publication/eur-scientific-and-technical-research-reports/critical-raw-materials-and-circular-economy-background-report>



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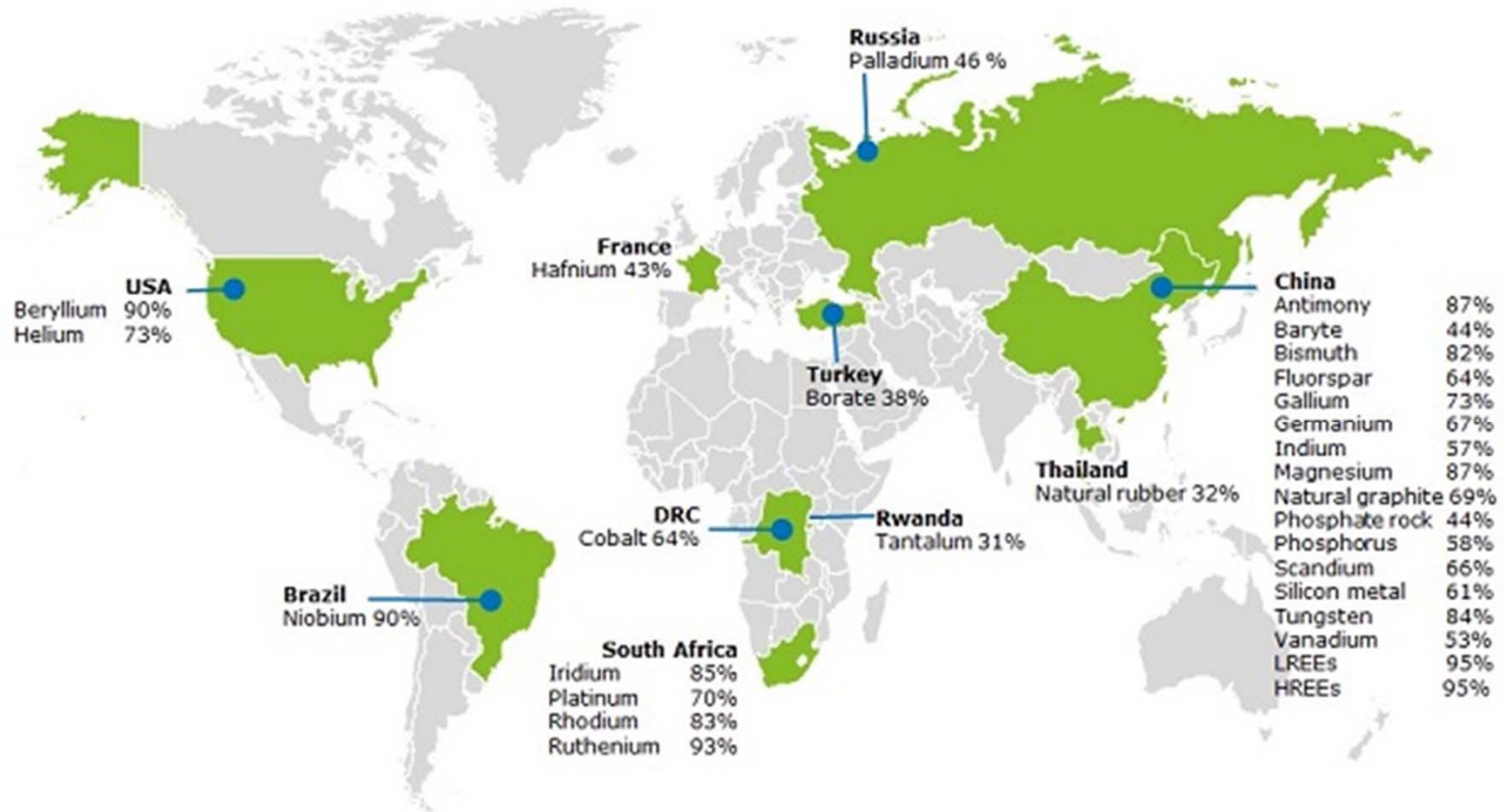
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# Production of CRMs



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# Robotics and rare earth metals

- Demand of the critical raw materials (CRMs) the most of which are critical due to risks of supply
- Rare earth metals (REMs) are needed to produce efficient magnets, optics, laser etc. and other metals (Co, Ni, Ti, Sc) for the production of robots
- Is it possible to use robotics for the problem solving in circular economy? – Yes!
- Robotics can be used to sorting of wastes



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# Health and clean technology

- Production of healthy food with minimum emissions and waste
- Pure water and water technology (quality of *drinking and plant irrigation water*)
- Purification of waste waters (*REMs, Pd, P, pharmaceuticals*)
- Packaging materials and clothing development and recycling (*plastic replacement materials, wood-based clothing*)



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# Energy and clean technology

- Solar and wind power systems and energy storage (*new efficient technologies, battery technology*) (*Ag, REMs, Li, Co & Ni*)
- Usage of biomass in energy production
  - wood materials (*burned to produce heat and electricity*)
  - agricultural crops and wastes (*burned or converted to biogas*)
  - animal manure and human waste (*biogas production*)



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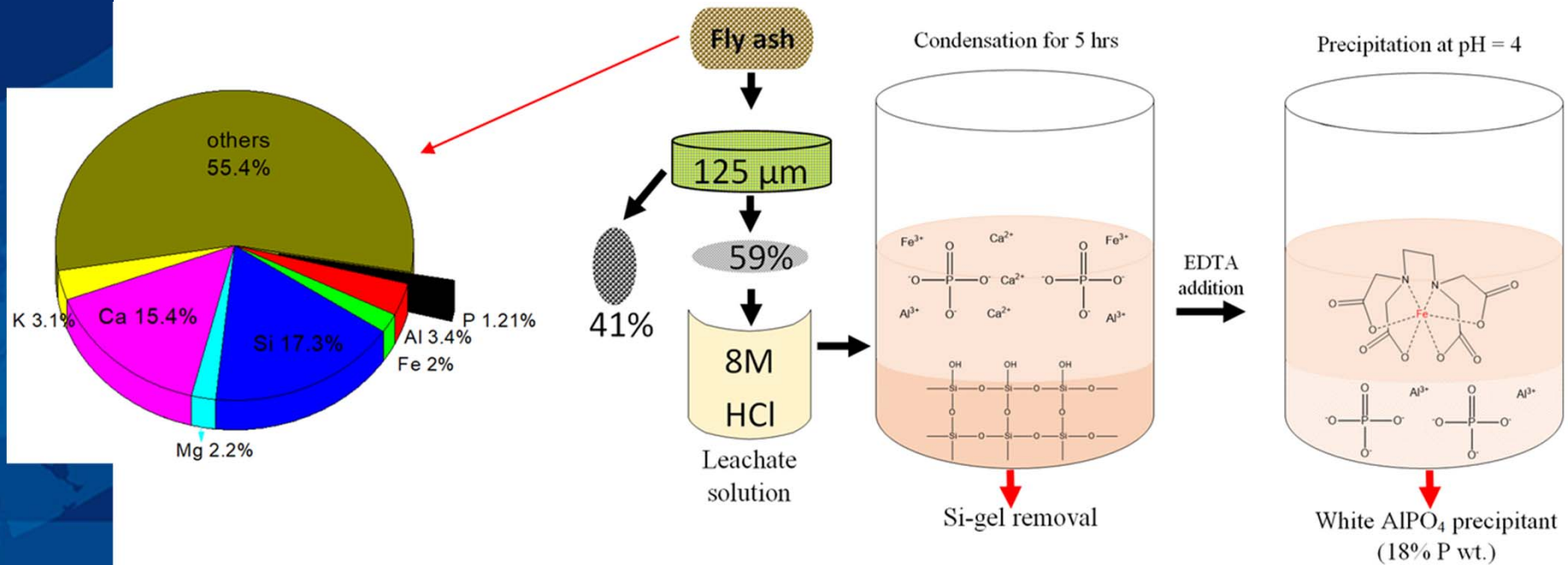
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- Wastes from biogas production and fly ashes of the combustion processes are potential raw material sources
- Phosphorus can be recovered from fly ash



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# Food and agriculture & soil

- Phosphorus is essential element for life (*recycling and effective use of phosphorus*)
- Functional food (*flavonoids and carotenoids*) In Finland berries and herbs



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