#EUCircularTalks - Critical Raw Materials - Improving existing life cycles of products to supply European markets

David Peck, Associate Professor, BK, Delft University of Technology (TU Delft), Netherlands
d.p.peck@tudelft.nl
Prometheus Missing:
Critical Materials and Product Design

23 July 1952 – European Coal and Steel Community

“to make war not only unthinkable but materially impossible” through regional integration
We have hit the ‘holy cow’ moment

Implementation of energy technologies

How energy technologies progress

Underestimate impact

How the human mind thinks about the future

Technology Introduction

Overestimate impact

Years

Adapted from Richard Baldwin: The Globotics Upheaval, 2019

Credit Rene Kleijn, 2022, Leiden University
## Critical Raw Materials

<table>
<thead>
<tr>
<th>2023 Critical Raw Materials (new CRMs in italics)</th>
</tr>
</thead>
<tbody>
<tr>
<td>aluminium/bauxite</td>
</tr>
<tr>
<td>antimony</td>
</tr>
<tr>
<td>arsenic</td>
</tr>
<tr>
<td>baryte</td>
</tr>
<tr>
<td>beryllium</td>
</tr>
<tr>
<td>bismuth</td>
</tr>
<tr>
<td>boron/borate</td>
</tr>
<tr>
<td>cobalt</td>
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<tr>
<td></td>
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</tbody>
</table>

https://rmis.jrc.ec.europa.eu/

TU Delft
Figure A: Results of the 2023 EU criticality assessment

Critical 2023
Non-Critical 2023
SR threshold
EI threshold

Elements and their criticality levels are plotted on a graph with Economic Importance on the x-axis and Supply Risk on the y-axis. The colors and symbols indicate whether the element is critical or non-critical for the EU.
Critical materials – half of the first 83 elements

- **Boron**
- **Fluorspar**
- **Magnesite**
- **Silicon metal**
- **Coking coal**
- **Conflict Minerals 3T+G**
  - Boron
  - Natural graphite
  - Phosphate rock
  - Feldspar
  - Bauxite

- **Platinum Group metals***

- **Light Rare Earths (LREE)**
  - Lanthanide series
    - La
    - Ce
    - Pr
    - Nd
    - Pm
    - Sm
    - Eu
    - Gd
    - Tb
    - Dy
    - Ho
  - Actinide series
    - Ac
    - Th
    - Pa
    - U
    - Np

- **Heavy Rare Earths (HREE)**
  - Eu
  - Gd
  - Tb
  - Dy
  - Ho
  - Er
  - Tm
  - Yb

* Elements contained in mobile phones. Source: (Meskers at al 2009), * in PCs (Soneji 2009) + WEEE (Dimitrakakis 2009)
© RHOS Elements (use in electronic appliances is restricted)
Country supply into EU concentration

Figure 5: Main EU suppliers of individual CRMs

- United States: Beryllium* 67%
- Mexico: Fluorspar 33%
- Guinea: Aluminium (bauxite) 63%
- Brazil: Niobium* 92%
- Chile: Lithium 79%
- United States: Silicon metal 35%
- Norway: Hafnium 76%
- Spain: Strontium 99%
- Morocco: Phosphate rock 27%
- DRC: Cobalt* 63%
- South Africa: Iridium* 93%
- Poland: Coking Coal Copper 27%
- Qatar: Helium 35%
- Russia: Palladium* 40%
- Kazakhstan: Phosphorus 71%
- China: Baryte 45%
- Bismuth 65%
- Cerium 85%
- Dysprosium 100%
- Erbium 100%
- Europium 100%
- Gadolinium 100%
- Gallium 71%
- Germanium 45%
- Holmium 100%
- Lanthanum 85%
- Lutetium 100%
- Magnesium 97%
- Natural Graphite 40%
- Neodymium 85%
- Praseodymium 85%
- Samarium 85%
- Scandium 67%
- Terbium 100%
- Thulium 100%
- Tungsten 32%
- Vanadium 62%
- Ytterbium 100%
- Yttrium 100%

* share of global production
italic = extraction stage
regular = processing stage
Short term, recycling is challenging

The Critical Raw Materials Act

The EU is aiming to ensure a secure and sustainable supply of critical raw materials for Europe's industry.
Top level targets by 2030

**EU EXTRACTION:**
at least 10% of the EU’s annual consumption from EU extraction

**EU PROCESSING:**
at least 50% of the EU’s annual consumption from EU processing

**EU RECYCLING:**
at least 20% of the EU’s annual consumption from domestic recycling

**EXTERNAL SOURCES:**
not more than 65% of the Union’s annual consumption of each strategic raw material at any relevant stage of processing from a single third country

**Step 1:** shortlist the CRMs potentially in the product group

<table>
<thead>
<tr>
<th>Material</th>
<th>Application</th>
<th>%</th>
<th>NACE-2 sector</th>
<th>COL-HIR</th>
<th>COL-LAR</th>
<th>High priority</th>
<th>Recycling</th>
<th>Durable</th>
<th>Use phase</th>
<th>Extending life</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bevillium</td>
<td>Electronic and telecommunications equipment</td>
<td>42%</td>
<td>C26 - Manufacture of computer, electronic and optical products</td>
<td>9% 9%</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Beryllium</td>
<td>Transport and defensive Vehicle electronics</td>
<td>17%</td>
<td>C26 - Manufacture of computer, electronic and optical products</td>
<td>9% 9%</td>
<td>X</td>
<td></td>
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<td></td>
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</tr>
<tr>
<td>Cobalt</td>
<td>Magnets</td>
<td>7%</td>
<td>C17 - Manufacture of electrical equipment</td>
<td>22% 12%</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Cobalt</td>
<td>Battery</td>
<td>3%</td>
<td>C27 - Manufacture of electrical equipment</td>
<td>22% 12%</td>
<td>x</td>
<td>x</td>
<td></td>
<td></td>
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<tr>
<td>Dysprosium</td>
<td>Magnets</td>
<td>30%</td>
<td>C25 - Manufacture of fabricated metal products, except machinery and equipment</td>
<td>0% 0%</td>
<td>X</td>
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<tr>
<td>Erbium</td>
<td>Lighting</td>
<td>56%</td>
<td>C27 - Manufacture of electrical equipment</td>
<td>1% 1%</td>
<td>X</td>
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<tr>
<td>Europium</td>
<td>Lighting</td>
<td>30%</td>
<td>C27 - Manufacture of electrical equipment</td>
<td>38% 14%</td>
<td>X</td>
<td>x</td>
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</tr>
<tr>
<td>Fluorpar</td>
<td>Refrigeration and air conditioning</td>
<td>9%</td>
<td>C27 - Manufacture of electrical equipment</td>
<td>1% 4%</td>
<td>X</td>
<td></td>
<td></td>
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</tr>
<tr>
<td>Gallium</td>
<td>Magnets</td>
<td>14%</td>
<td>C25 - Manufacture of fabricated metal products, except machinery and equipment</td>
<td>4% 4%</td>
<td>x</td>
<td>x</td>
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<tr>
<td>Gadolinium</td>
<td>Lighting</td>
<td>15%</td>
<td>C27 - Manufacture of electrical equipment</td>
<td>1% 1%</td>
<td>X</td>
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<tr>
<td>Galium</td>
<td>Magnetic resonance imaging - MRI</td>
<td>8%</td>
<td>C26 - Manufacture of computer, electronic and optical products</td>
<td>1% 1%</td>
<td>X</td>
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<tr>
<td>Gallium</td>
<td>Integrated circuits</td>
<td>10%</td>
<td>C26 - Manufacture of computer, electronic and optical products</td>
<td>9% 9%</td>
<td>X</td>
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</tr>
<tr>
<td>Gallium</td>
<td>Lighting</td>
<td>13%</td>
<td>C27 - Manufacture of electrical equipment</td>
<td>0% 2%</td>
<td>x</td>
<td></td>
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</tr>
<tr>
<td>Gallium</td>
<td>CIGS solar cells</td>
<td>5%</td>
<td>C26 - Manufacture of computer, electronic and optical products</td>
<td>0% 9%</td>
<td>X</td>
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<tr>
<td>Germanium</td>
<td>Infrared optics</td>
<td>47%</td>
<td>C26 - Manufacture of computer, electronic and optical products</td>
<td>3% 17%</td>
<td>X</td>
<td></td>
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</table>

**Step 2:** collect quantitative data on the Bill of Material for the shortlisted CRMs

**Step 3:** look at available information from criticality assessment to define possible strategies, e.g.:
- Declare quantity (when data is not available)
- Extend lifetime (especially in the case of low substitutability)
- Improve recyclability and/or recycled materials (especially in the case of low substitutability)
The Net Zero Industry Act

EU NET-ZERO INDUSTRY ACT: MAKING THE EU THE HOME OF CLEAN TECH INDUSTRIES

March 2023

David Peck
40% made in EU by 2030

- Solar photovoltaic and solar thermal
- Electrolysers and fuel cells
- Onshore wind and offshore renewables
- Sustainable biogas/biomethane
- Batteries and storage
- Carbon capture and storage
- Heat pumps and geothermal energy
- Grid technologies

40% made in Ireland by 2030? Why not?
CRM – CBE Creating a shared understanding: the “Scales to Aspects” Model
CRM in buildings

Heat pumps

Data storage and servers

Data transmission networks

Additive manufacturing (AM)

Robotics

Wind turbines

Traction motors

Solar photovoltaics (PV)

Urban-Integrated Photovoltaics (UIPV)

Built-Added Photovoltaics (BAPV)

Building/Invisibly Integrated Photovoltaics (BIPV/UIPV)

Li-ion batteries

Adze Boerstra, 2022

Charley Meyer, 2018

Tillmann Klein, 2020

Adapted from Steward Brand - How buildings learn

LIFESPAN (Change)

Stuff
Space
Services
Structure
Skin
Site
The use of critical raw materials in façades and the call for circularity: identifying dependencies and planning for the future

Fröwis, Alexandra
Figure 3.20: Motors and sensor parts in the curtain wall analysis
Reman operations

- Reverse logistic
- **Remanufacturing**
  - Control
  - Cleaning
  - Disassembly
  - Storage
  - Remanufacturing
  - Reassembly
  - Testing
Current challenges of remanufacturing

Remanufacturing and industry 4.0

- Improved Decision Making
- Resource Productivity and Efficiency
- Flexibility / Agility
- Customer Responsiveness
- Value through New Services

Source: KPMG, 2018. A reality check for today’s C-suite on Industry 4.0 The time for experimentation is ending
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Thank you