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How to assess Critical Raw Materials-related supply risk in early design?

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1. Introduction: Critical raw materials in Europe

What materials are we talking about?

Photovoltaic panels
(Gallium, Indium, Germanium, Silver)

LCD screens
(Indium, RE, Silver, Tantalum)

Wind turbines
(Rare earths (RE): Nd, Pr, Dy, Tb)

LED
(Gallium)

Aerospace
(Rhenium, Beryllium, Tungsten, Scandium, Cobalt)

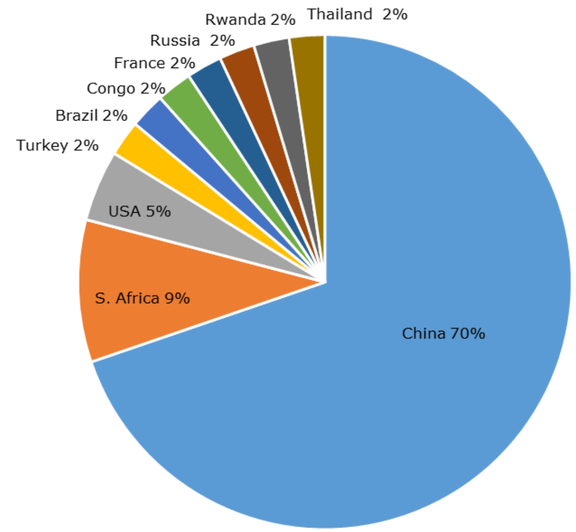
And also:

- **Electric and electronic devices**
- **Batteries**
- **Defence sector**
- **Chemical industry**
- **....**

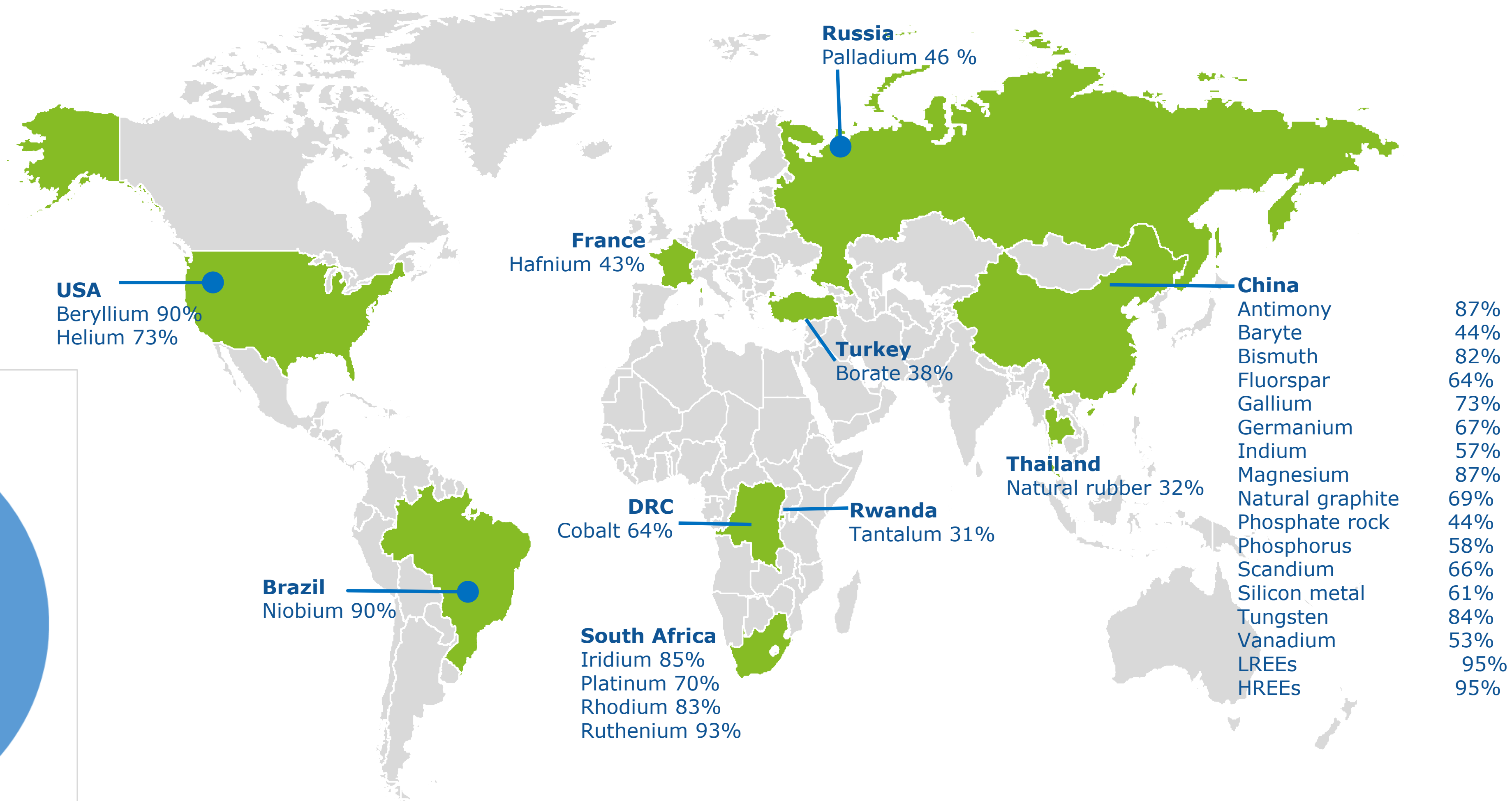
Why are they critical?

Subject to a higher risk of supply interruption: high concentration of production in one country, low political-economic stability of main supplier(s), low substitutability and low recycling rates of the raw material itself

Countries accounting for largest share of global supply of CRMs

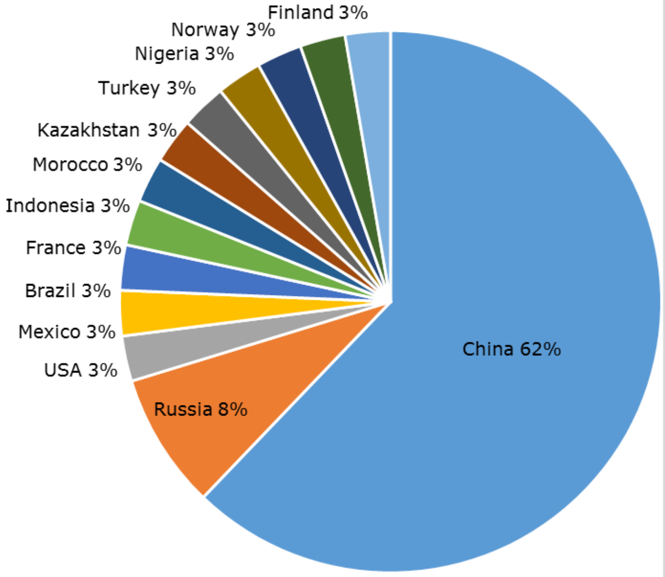


Primary global suppliers of CRMs (% based on number of CRMs supplied out of 43)



EU sourcing of CRMs

Countries accounting for largest share of EU supply of CRMs



Main EU suppliers of CRMs,
(% based on number of CRMs supplied out of 37)

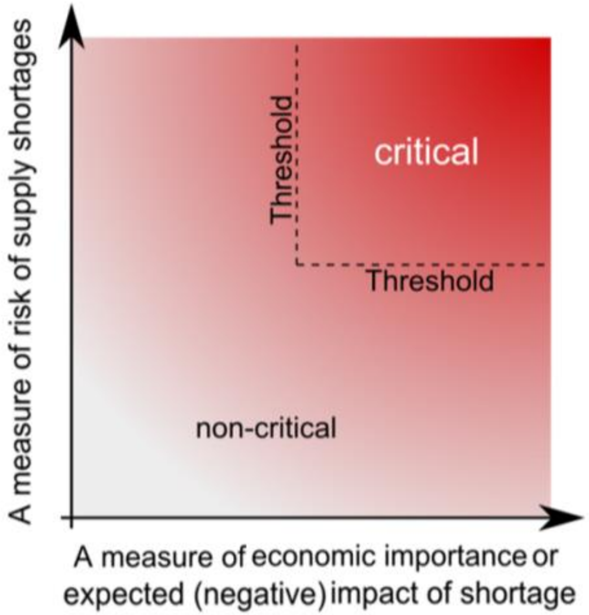
Assessment of the Criticality of raw material in EU

2010	2011	2014	2015	2017
Methodology development	1st list of CRM 41 materials assessed	2nd list of CRM 54 materials assessed	Update of the methodology	3rd list of CRM 80 materials assessed

The EU methodology assesses criticality as a combination of two parameters:

- Economic importance
- Supply risk

General scheme of the criticality concept projected into 2 dimensions.



2. Supply risk related to critical raw materials into LCA

Supply risk related to critical raw materials into LCA

Presently, there is a growing challenge of securing access to those metals and minerals needed for economic production. Indeed, many materials are essential for the development of high tech products and emerging innovations, which are necessary for the space sector.

A CRM supply risk indicator as a decision-support tool could help:

- identify potential future risks
- monitor the risks
- identify mitigation actions (e.g. recycling actions, substitution).

The objectives of the project conducted with ESA are:

1. To develop and validate an adaptation of the LCA methodology to identify and flag the supply risks due to CRM use for the European space sector through the complete life-cycle of space products
2. To establish how LCA can help anticipate supply risks and demonstrate through one specific case study

Characteristics of the criticality indicator for the European space sector

Which parameters to consider?

Review of 10 studies related to integrate criticality aspects into LCA → Numerous indicators already developed to assess resource and supply risk, but there is a **need to find a consensus among different methods**

From this review, the criticality indicator used for the European space sector should ideally include the following concepts:

- Global producers concentration, balanced with their governance stability
- Suppliers concentration, balanced with their governance stability
- Recycling rate
- Substitutability
- Trade barriers or agreements

Those concepts are already included in the new 2017 methodology developed by the JRC to assess the supply risk indicator

Definition of the criticality indicator for the European space sector (1/2)

The supply risk related to critical raw material availability is based on the supply risk parameter in the **2017 criticality methodology for the EU**. The supply risk of this methodology considers the following parameters:

- the market concentration of supplying countries;
- the governance;
- trade characteristics of those countries.

These parameters are considered for the world supply mix (or global supply) and for the EU supply mix respectively. The recycling and substitution of the raw materials are also considered in the updated version of the parameter. The following formula is applied:

$$SR = \left[(HHI_{\mathrm{WGI}-t})_{GS} \times \frac{\mathrm{IR}}{2} + (HHI_{WGI-ta})_{EUsourcing} \times \left(1 - \frac{\mathrm{IR}}{2}\right) \right] \times (1 - EoL_{RIR}) \times SI_{SR}$$

Import reliance

Supplying countries concentrations for global suppliers

Supplying countries concentrations for European suppliers

Recycling parameter

Substitutability of a raw material

Definition of the criticality indicator for the European space sector (2/2)

Two adaptations of this formula were made:

$$SR_{sp} = \left[(HHI_{WGI-t})_{GS} \times \frac{IR}{2} + (HHI_{WGI-ta})_{EUsourcing} \times \left(1 - \frac{IR}{2}\right)\right] \times (1-) EoL_{RIR} \times SI_{SR}$$

Definition of the criticality indicator for the European space sector (2/2)

Two adaptations of this formula were made:

1) the weighting factor of substitutability was recalculated. The share of each substitute was reassessed to solely consider relevant substitution materials for the space sector.

$$SR_{sp} = \left[(HHI_{WGI-t})_{GS} \times \frac{IR}{2} + (HHI_{WGI-ta})_{EUsourcing} \times \left(1 - \frac{IR}{2}\right) \right] \times (1-) EoL_{RIR} \times SI_{SR-space}$$

Definition of the criticality indicator for the European space sector (2/2)

Two adaptations of this formula were made:

1) the weighting factor of substitutability was recalculated. The share of each substitute was reassessed to solely consider relevant substitution materials for the space sector.

New formula

$$SR_{sp} = \left[(HHI_{WGI-t})_{GS} \times \frac{IR}{2} + (HHI_{WGI-ta})_{EUsourcing} \times \left(1 - \frac{IR}{2}\right)\right] \times (1-)EoL_{RIR} \times SI_{SR-space} \times RDF$$

2) A reserve depletion factor was included to discriminate which elements will be more easily available in the long run, based on their extractable amount and production rate. **Only the core definition of the Abiotic Depletion Potential (used in LCA) was used**, with the ratio of stocks on deposits in the environment. The latest JRC dataset regarding the quantity of reserve available and the extraction rate was mostly used. The reserve depletion factor (RDF) included in the SR formula for the raw material i is set to be in the range [1;1.1].

Integration of the criticality indicator into LCA

Once the supply risk of each material have been defined, the supply risk indicators should be applied to a space-specific system.

Hereunder is the description of the general procedure:

1 – Mapping between the CRM & elementary flows of the LCA database

Main challenge: the LCA database might not cover all the CRMs.

2 – Implementation of the 'characterization' method of the risk

Main challenge: To characterize only the presence of CRM into the studied system, and flag where the consumption of CRM occurs.

3. Interim conclusions & next steps

Interim conclusions and next steps

Interim conclusions

- The identification of a the potential CRM-related supply risks can start as early as possible in the project, and has to continue throughout its lifetime.
- The view that the LCA framework provides on the space value chain can help flag the supply risk at early design stage and could be addressed in the context of selecting alternative design options and R&D.

Next steps

- We are developing an illustrative case study, to fine tune the methodology and illustrate what could be the added value of LCA regarding CRM-related supply risk identification.

Thank you for your attention!

Any questions?

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