Supply chain analysis and material demand forecast in strategic technologies and sectors in the EU

RGI's Expert Exchange Workshop 'Closing the Circle: Supply Chains and Circularity Approaches for Delivering a Decarbonised Energy System', Brussels

26.06.2024

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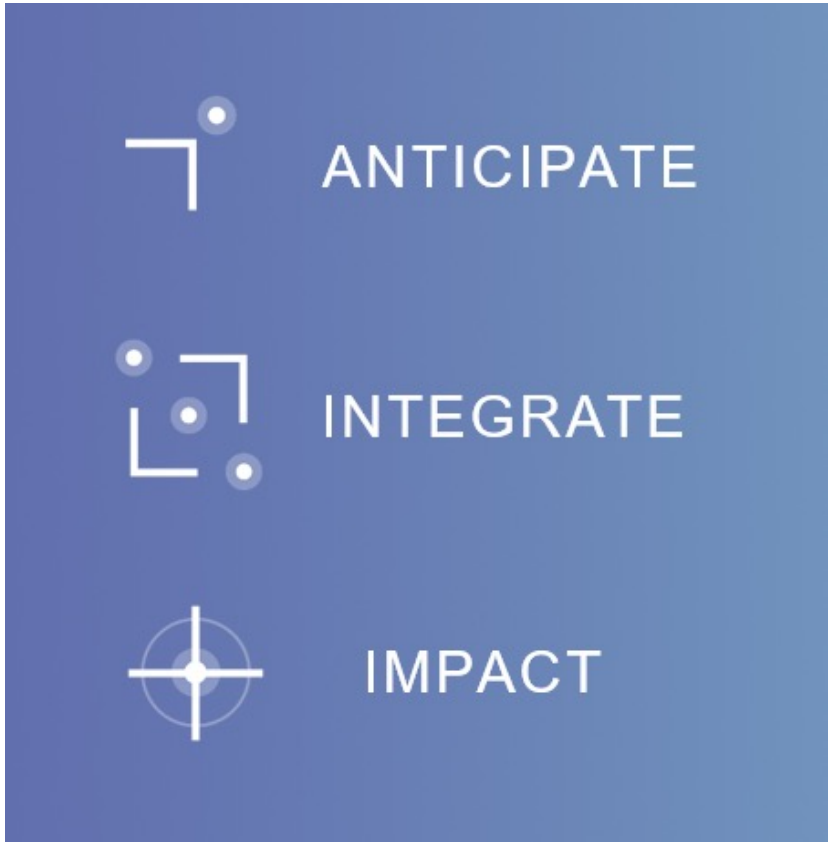
Science for policy



Our purpose

The Joint Research Centre provides independent, evidence-based knowledge and science, supporting EU policies to positively impact society.

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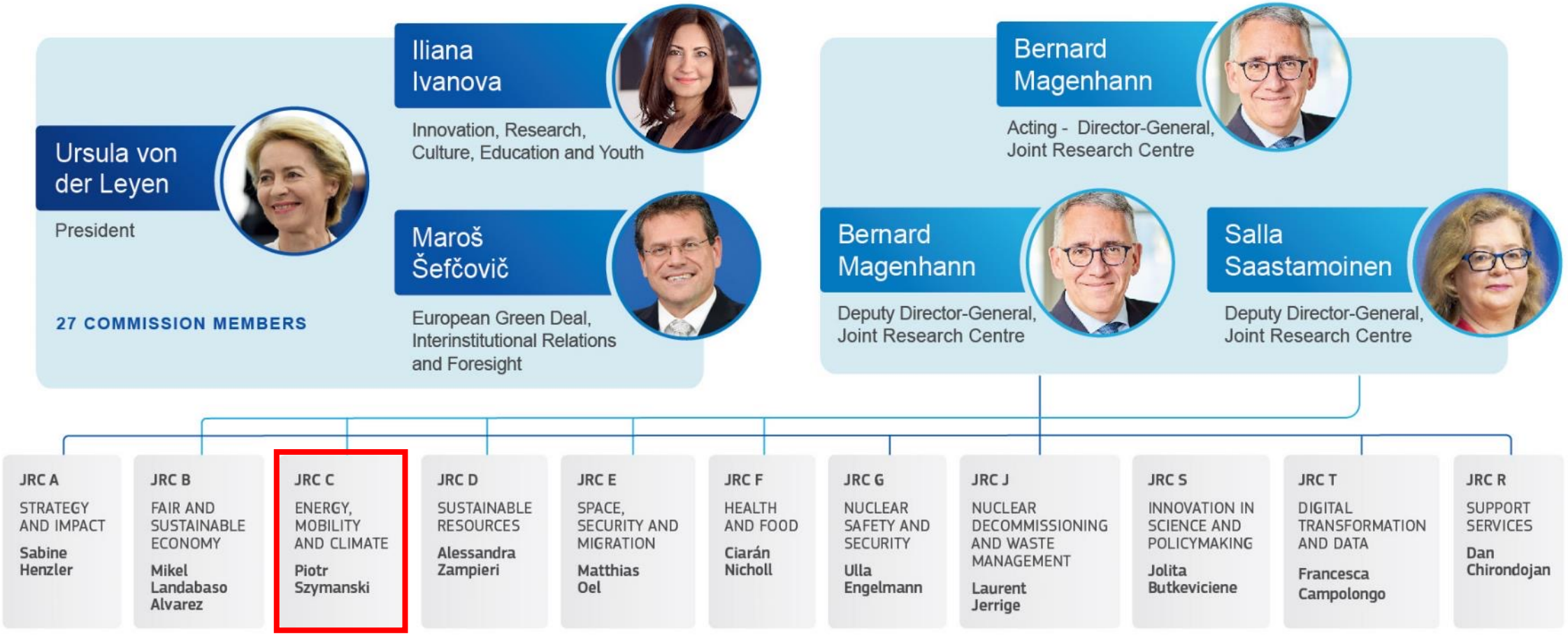

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JRC sites

Headquarters in **Brussels** and research facilities located in **five EU Countries:**

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- Germany (Karlsruhe)
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- The Netherlands (Petten)
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Role of Clean energy materials and their supply in the Energy Transition

Energy transition:
Rapid deployment of renewables to meet climate targets
Shift from *fuels* to *technologies, manufacturing, materials*

➢ The **energy transition** is a **materials transition**

- Manufacturing renewable plants, electric vehicles, etc. requires **raw materials** and a whole **supply chain** up to the final technology
- Which are our **materials needs** for meeting our targets and how **resilient** is their supply?

Critical Raw Materials Act

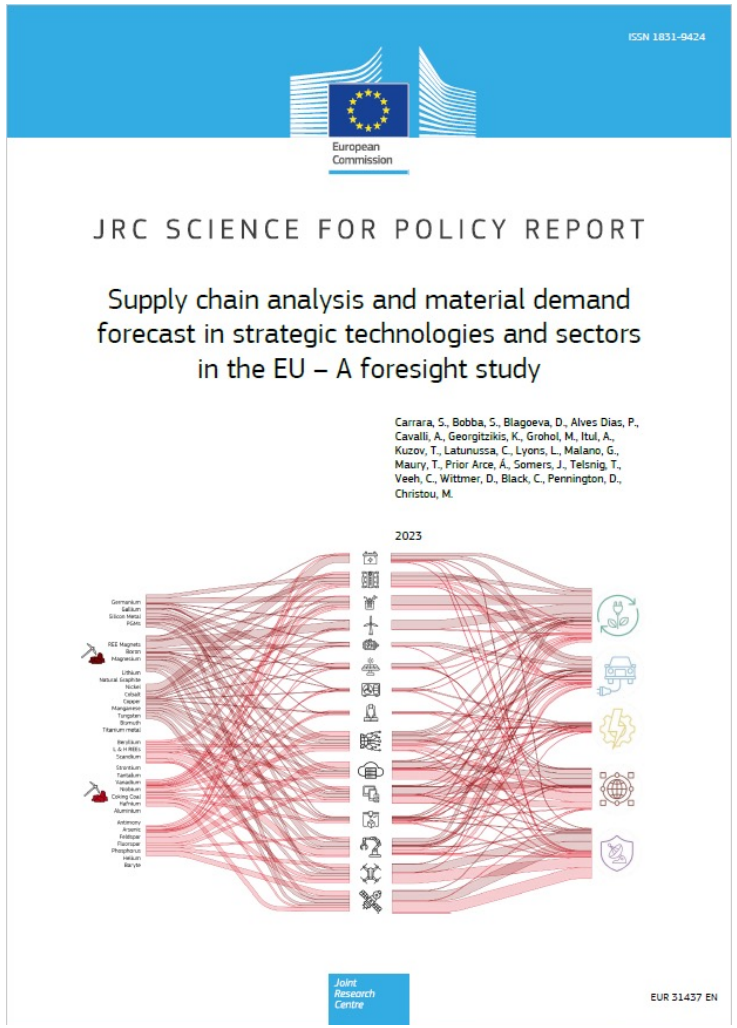
Ensuring a secure and sustainable supply of critical raw materials for the EU

- Setting priorities
- Creating secure and resilient supply chains
- Risk monitoring and mitigation
- Improving sustainability and circularity of critical raw materials on the EU market
- Diversifying the EU imports of raw materials

2023 Critical and Strategic Raw Materials

including Strategic Raw Materials (in red), new CRM in **bold**, ex-CRM ~~struck out~~			
Antimony	Coking Coal	Lithium	Phosphorus
Arsenic	**Feldspar**	Light Rare Earth Elements	Scandium
Baryte	Fluorspar	Magnesium	Silicon Metal
Bauxite/Aluminium	Gallium	**Manganese**	Strontium
Beryllium	Germanium	Graphite	Tantalum
Bismuth	Hafnium	Niobium	Titanium Metal
Boron	**Helium**	Platinum Group Metals	Tungsten
Cobalt	Heavy Rare Earth Elements	Phosphate Rock	Vanadium
~~Natural Rubber~~	~~Indium~~	**Copper***	**Nickel***

Materials and supply chains – Foresight report



Two main dimensions:

- Supply chain analysis
- Demand forecast and supply/demand balance

Foresight report:
15 technologies in 5 strategic sectors
(renewable energy, e-mobility, energy-intensive industry, ICT, aerospace & defence)

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Supply chain analysis

What are the components, the processed and the raw materials used in clean energy technologies?

Is the EU exposed to any vulnerability along the supply chains?

What actions can be taken to overcome these bottlenecks?

How can the European industrial development be supported?

Supply chain analysis – Wind: raw materials

Iron: as cast iron or in steel composition for tower, nacelle, rotor and foundation; in neodymium–iron–boron (NdFeB) permanent magnets

Chromium: essential for stainless steel and other alloys in rotor and blades

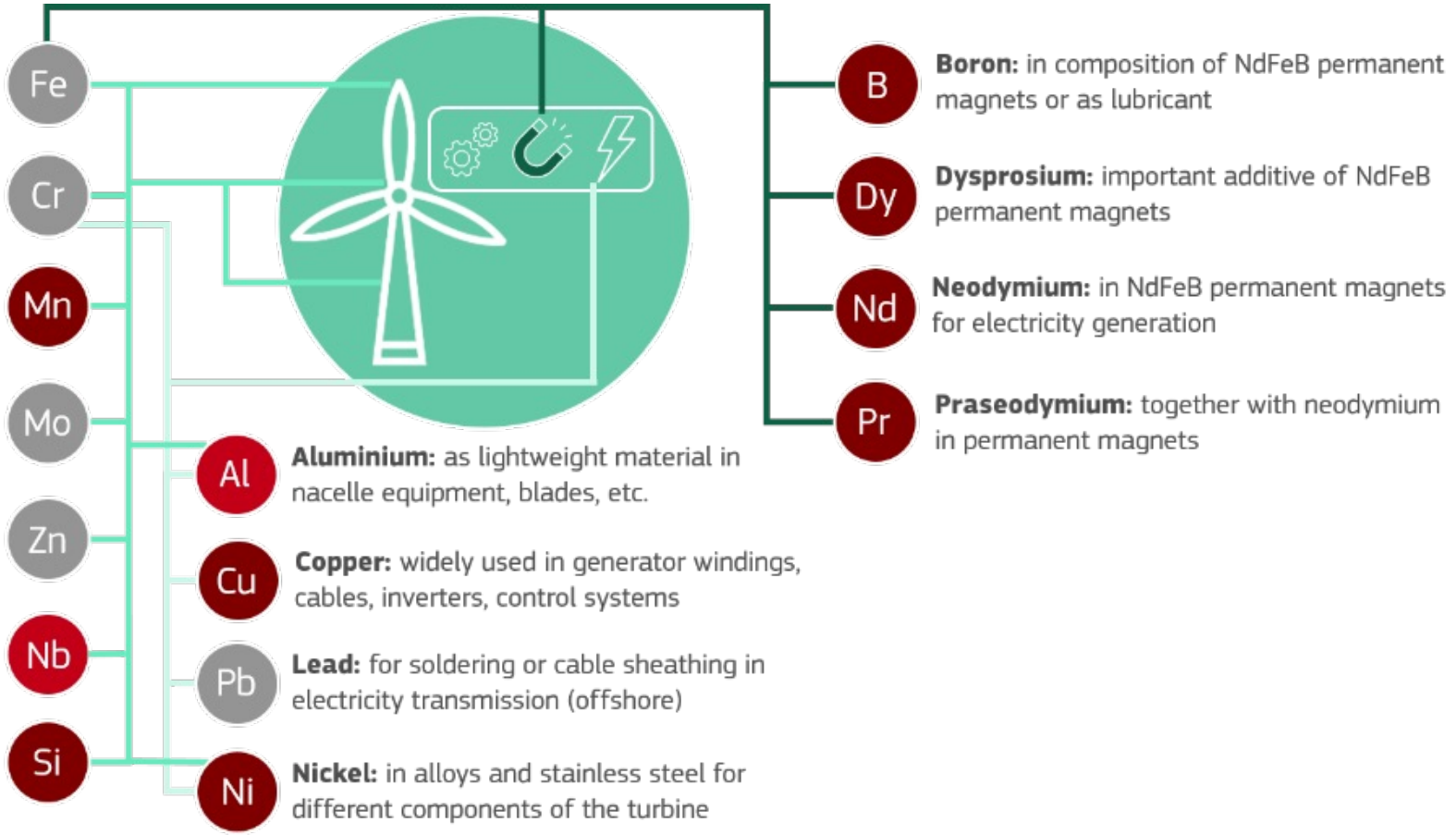
Manganese: essential for steel production used for many parts of a turbine

Molybdenum: in stainless steel composition for many components of the turbine

Zinc: in protective coatings against corrosion

Niobium: a microalloying element in high strength structural steel for towers of a turbine

Silicon: as alloying element in high-performance steels and as silicone in polymers (sealants, adhesives, lubricants)



Aluminium: as lightweight material in nacelle equipment, blades, etc.

Copper: widely used in generator windings, cables, inverters, control systems

Lead: for soldering or cable sheathing in electricity transmission (offshore)

Nickel: in alloys and stainless steel for different components of the turbine

Boron: in composition of NdFeB permanent magnets or as lubricant

Dysprosium: important additive of NdFeB permanent magnets

Neodymium: in NdFeB permanent magnets for electricity generation

Praseodymium: together with neodymium in permanent magnets

Strategic Raw Material

Critical Raw Material

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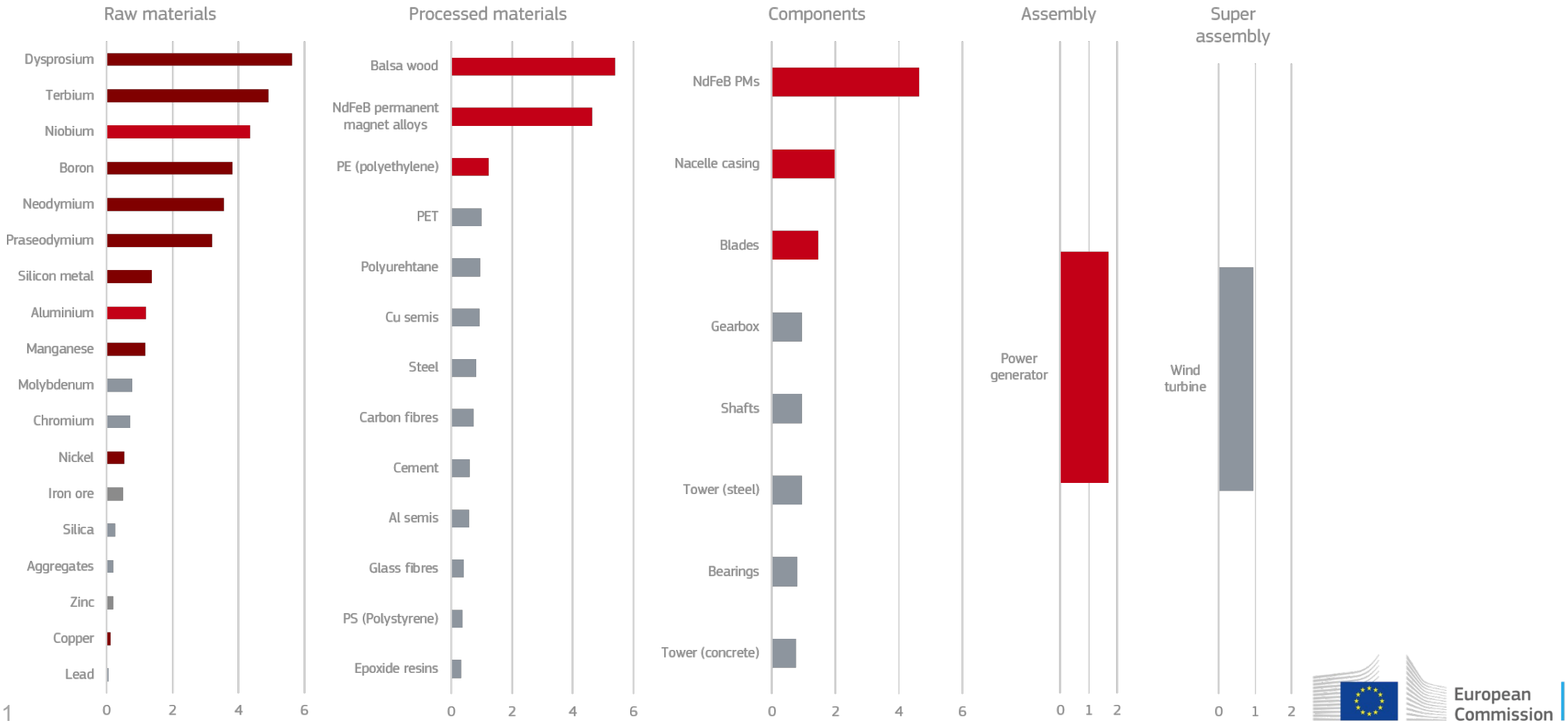
Supply chain analysis – Wind: supply chain (I)



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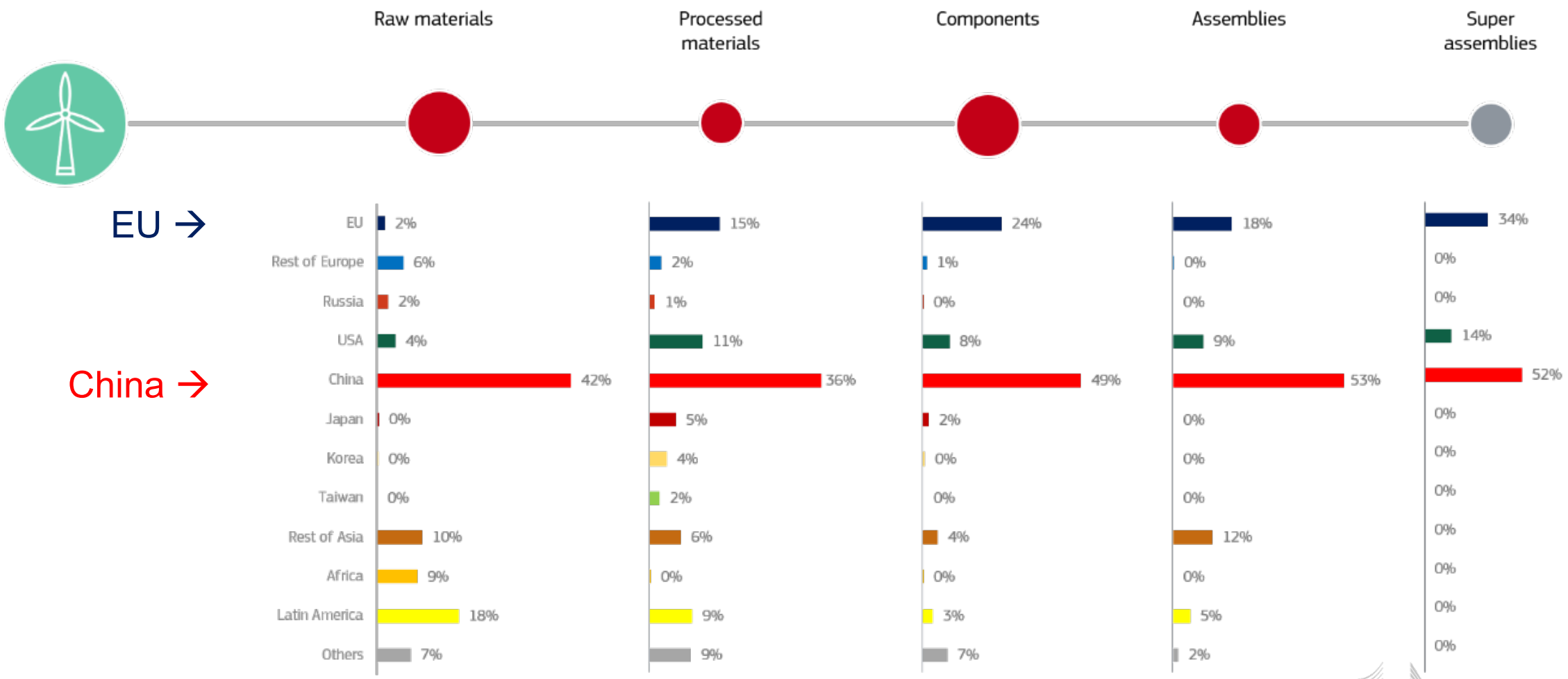
Supply chain analysis – Wind: supply chain (II)



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Supply chain analysis – Solar PV: raw materials

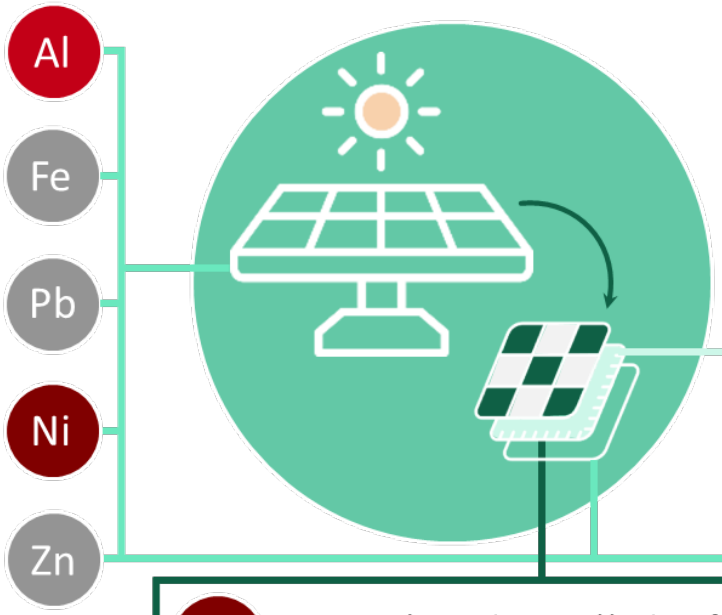
Aluminium: in panel frames and inverters or in alloys for construction and support

Iron: in steel alloys for different parts and in fixing systems

Lead: in alloys with tin as solder for electric circuits and interconnectors

Nickel: in electroplating or in stainless steel frames, fasteners and connectors

Zinc: as transparent conductive oxide in the front contact of solar cells



Boron: as dopant in crystal lattice of the silicon-based wafers

Germanium: as semiconductor materials for multi-junction solar cells for space applications

Silicon: as semiconductor materials in crystalline solar cells

Silver: as conductive paste on front and back side of the crystalline solar cells

Copper: highly used for wires, cables, inverters, also in thin-film copper indium gallium selenide (CIGS) technology

Selenium: in thin-film CIGS solar cell

Indium: as indium-tin-oxide (ITO) conductive layer or in CIGS technology

Molybdenum: as back contact for CIGS or in stainless steel frames

Gallium: as dopant in semiconductors or in CIGS technology

Tin: in combination with lead for soldering or with indium in ITO conductive layers

Tellurium and Cadmium: in thin-film cadmium telluride (CdTe) PV technology

Strategic Raw Material

Critical Raw Material

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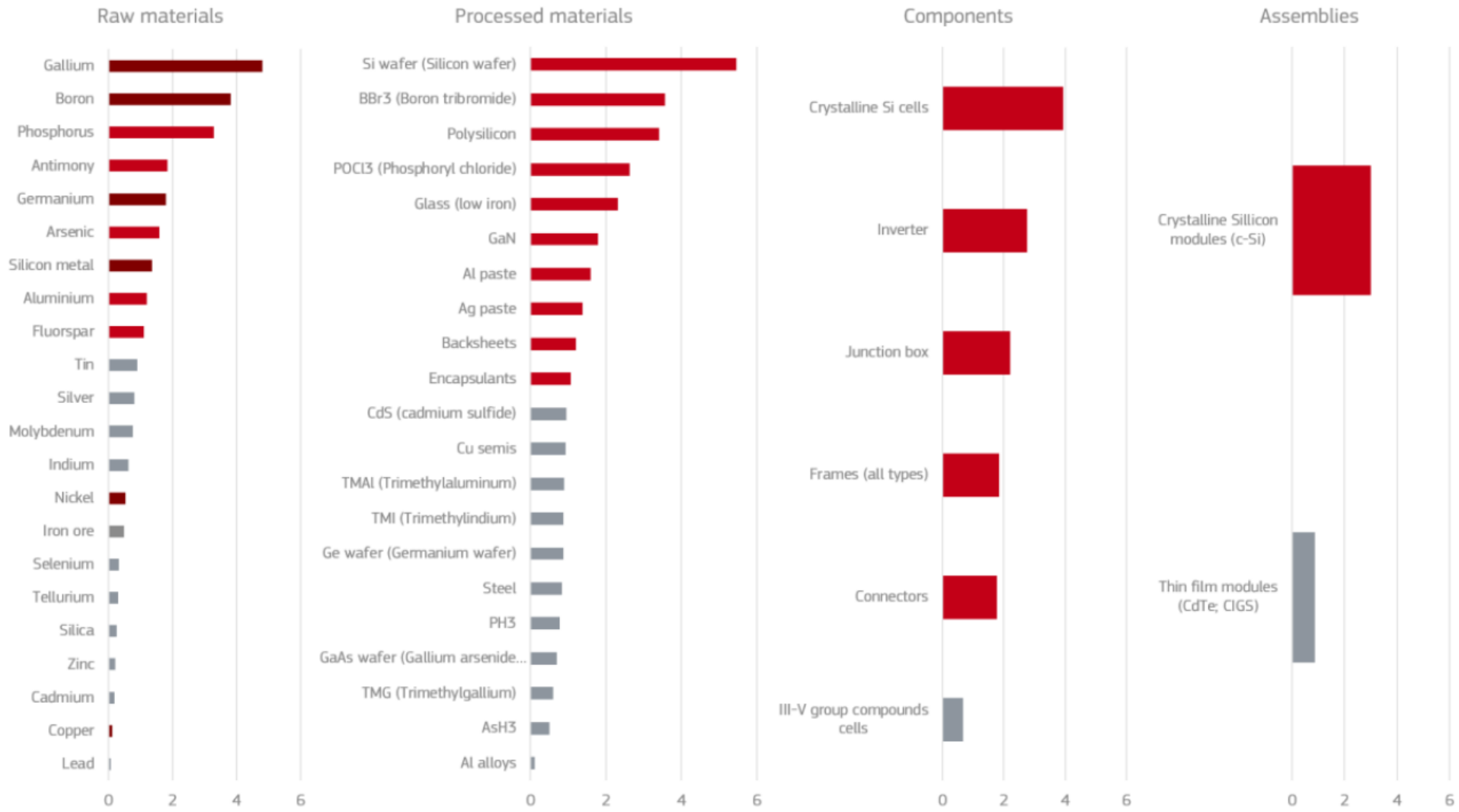
Supply chain analysis – Solar PV: supply chain (I)



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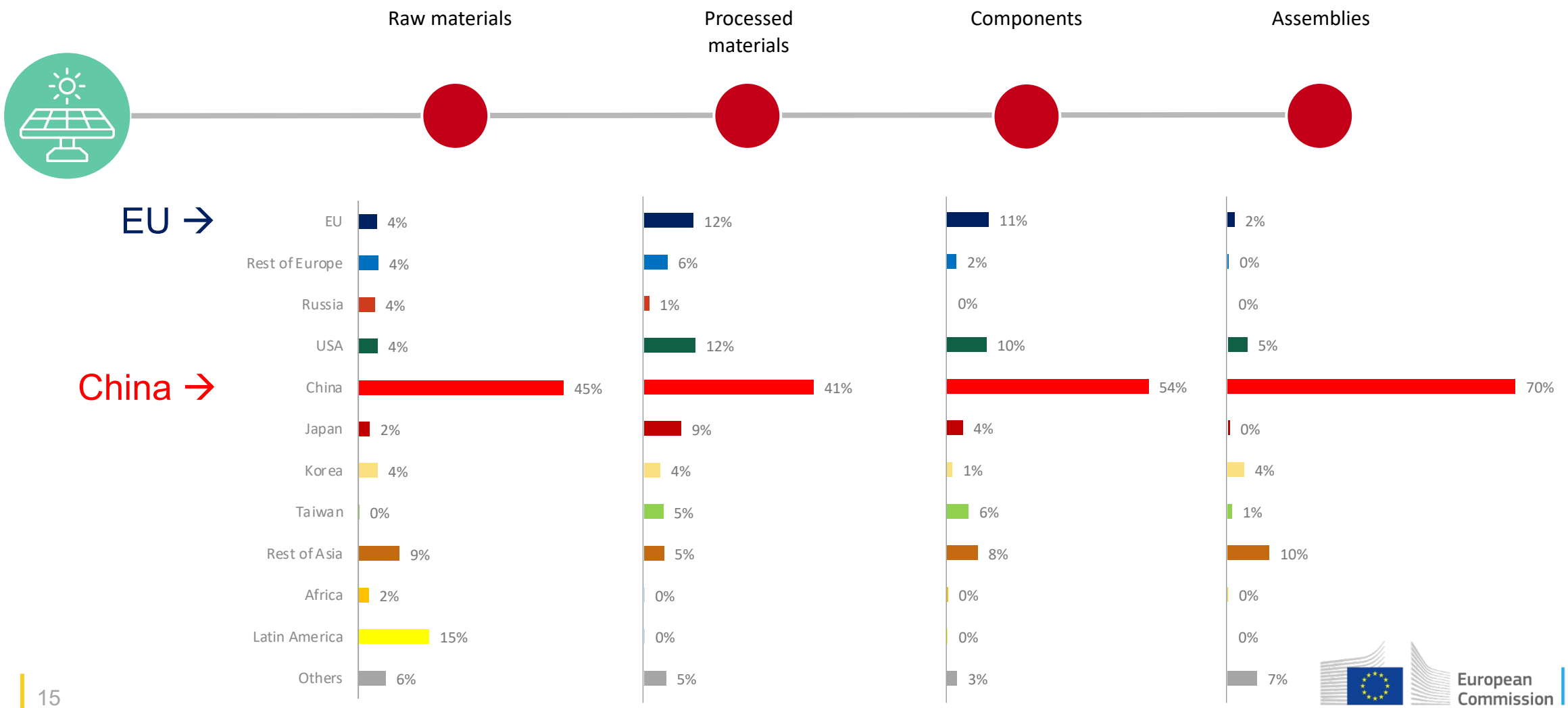
Supply chain analysis – Solar PV: supply chain (II)



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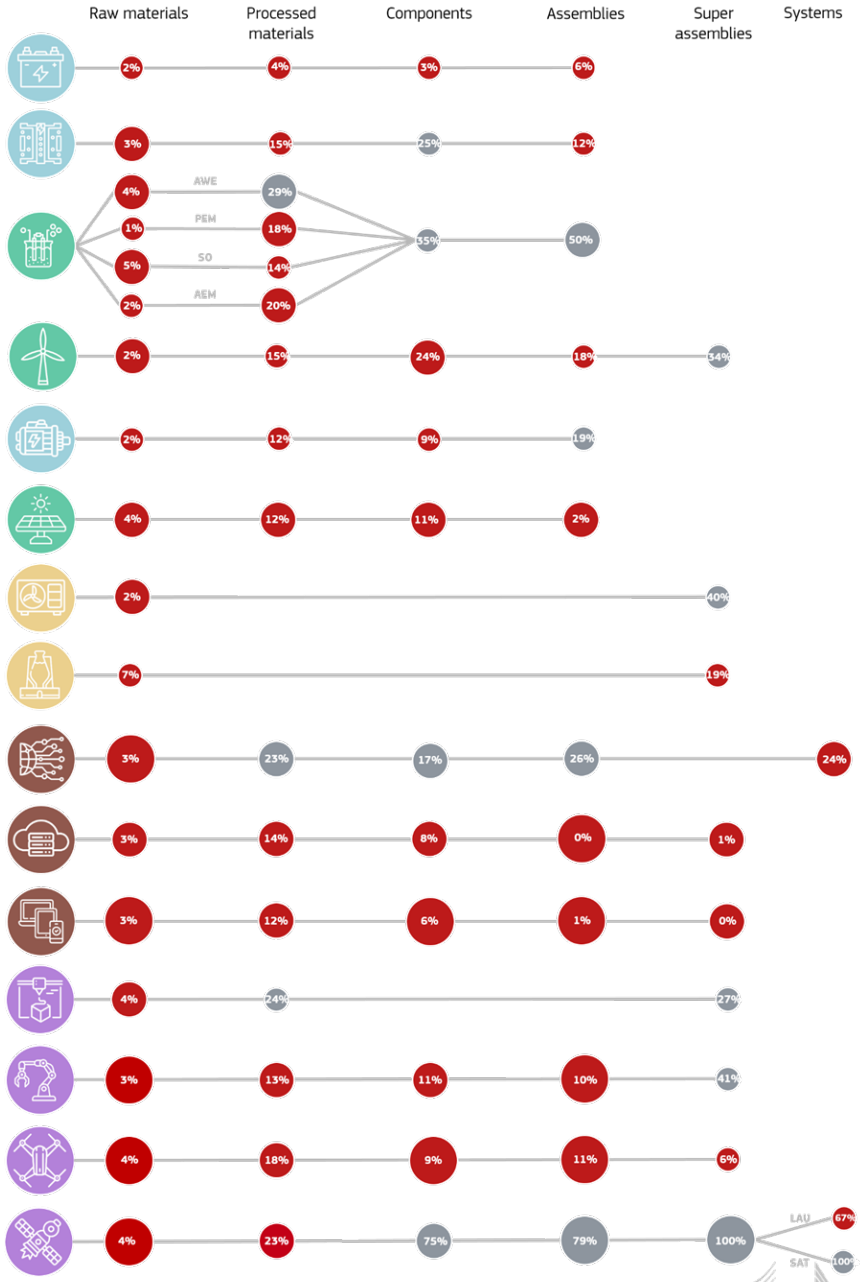
Supply chain analysis – Technology overview

Technologies: Li-ion Batteries, Fuel cells, Electrolysers, Wind turbines, Traction motors, solar PV panels, Heat pumps, H2-DRI, Data transmission networks, Data storage and servers, Mobile Devices, 3D printing, Robotics, Drones, Space launchers and satellites.

- **EU shows significant vulnerability along the supply chains examined**: only 17 bubbles are grey out of a total of 70.
- T**he raw materials step is systematically critical for all technologies**. Here, the EU share in global production is never higher than 7%.
- The EU is **reasonably strong in the manufacturing** of the final technologies.



Percentages in the bubbles show the EU shares of production and are <u>not</u> directly related to the bubble colour!

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Demand foresight and supply/demand balance

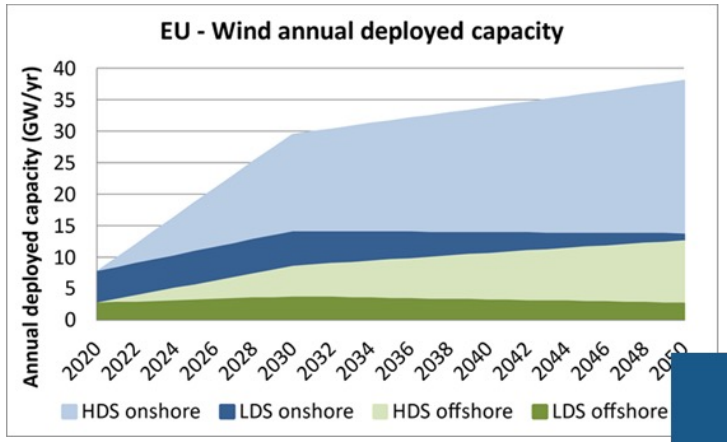
What will be the future demand of energy technologies, components, processed and raw materials?

How does future demand compare to supply?

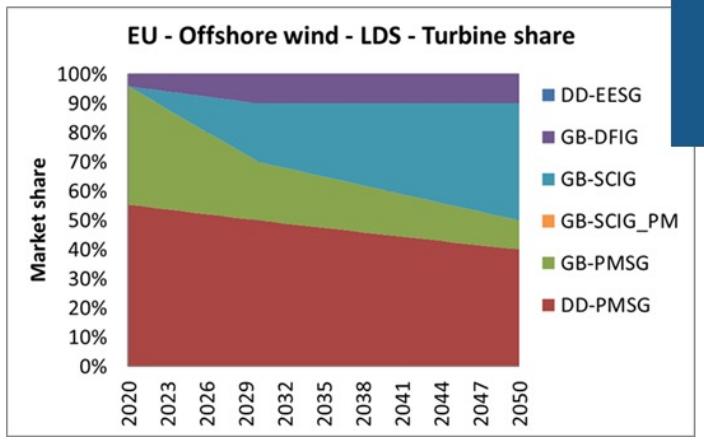
Which materials have a critical demand growth?

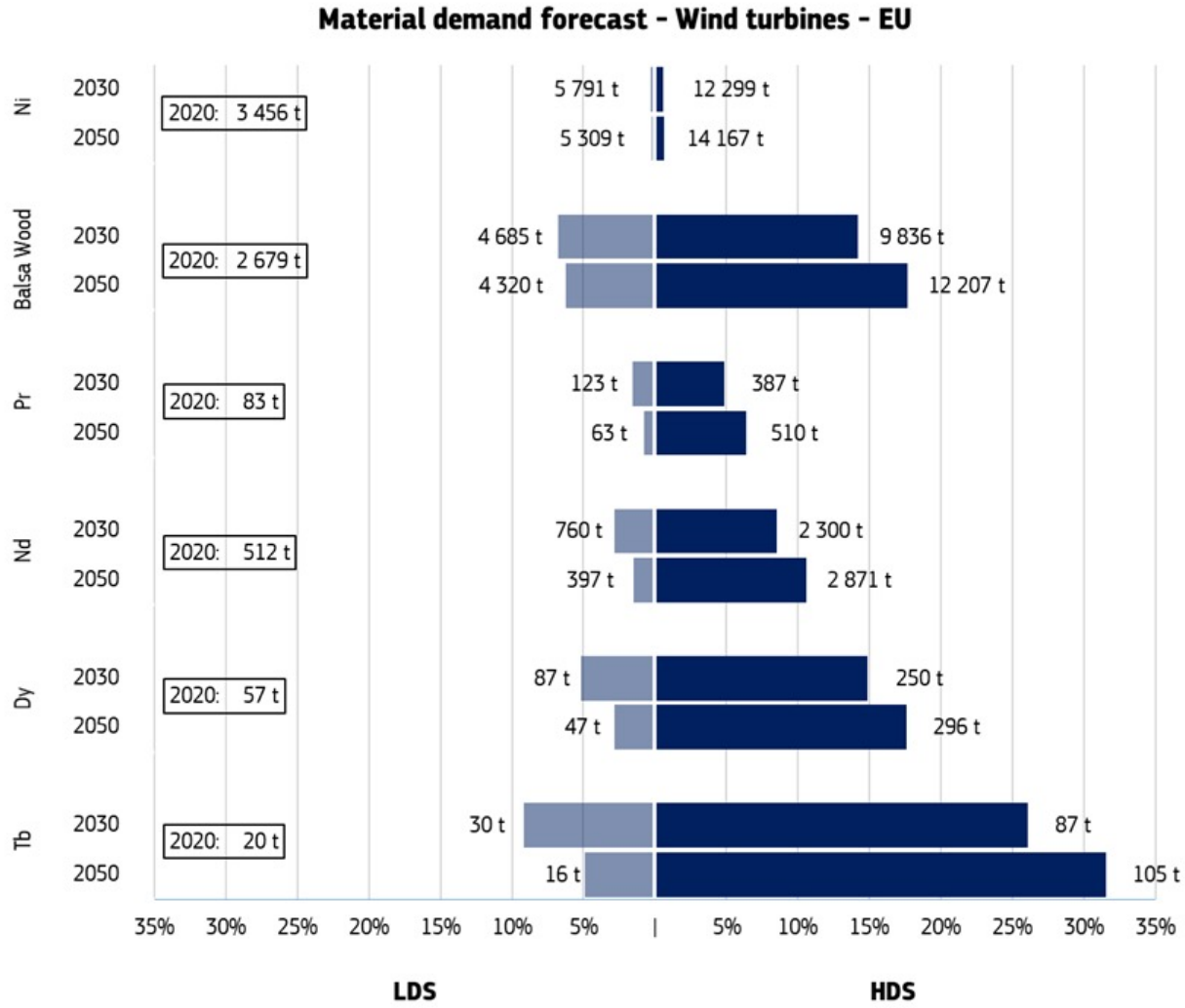
What are the effects of technological developments and material intensity?

Forecast analysis – Material demand scenarios

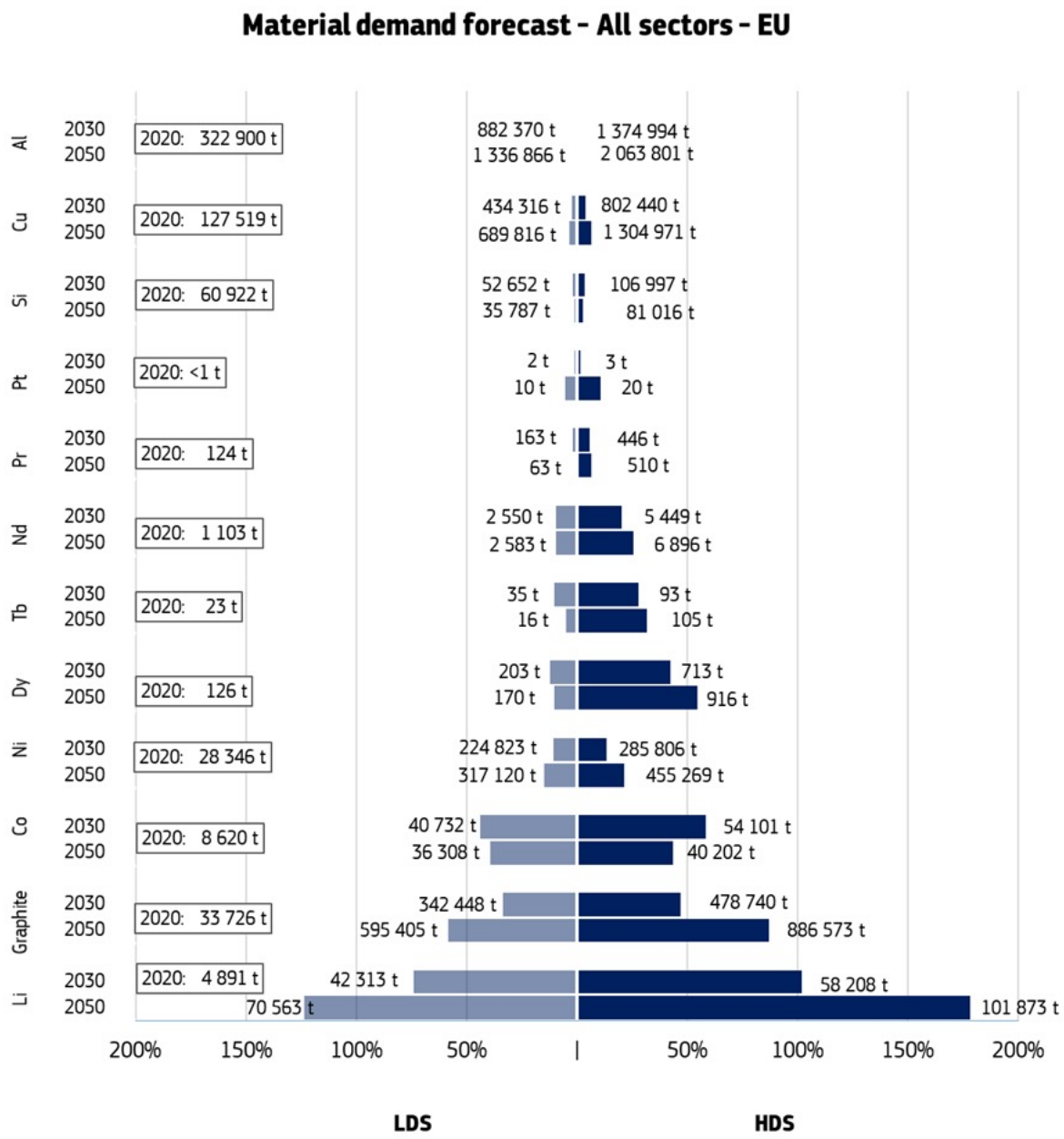


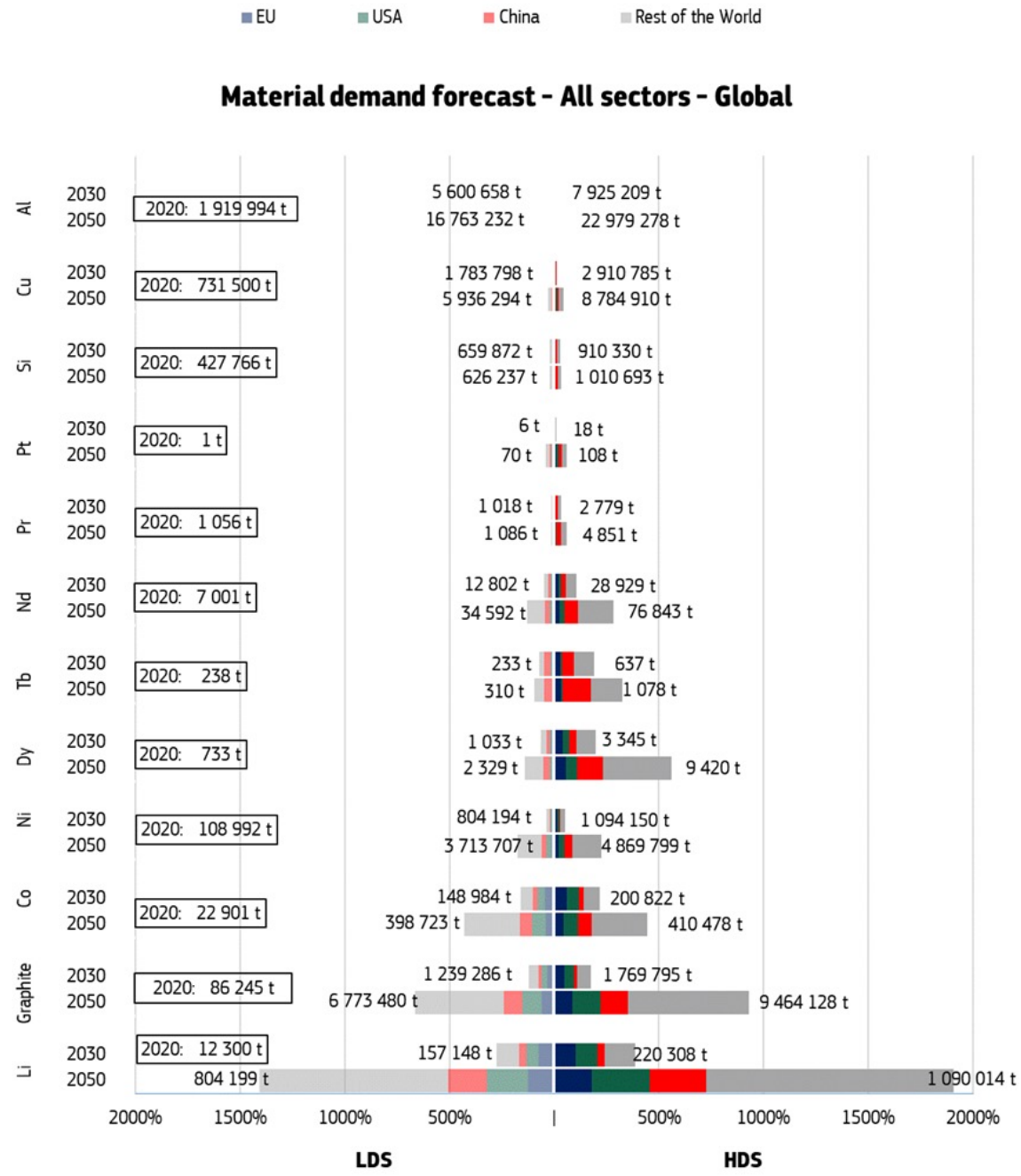
Materials intensities
for the different technologies





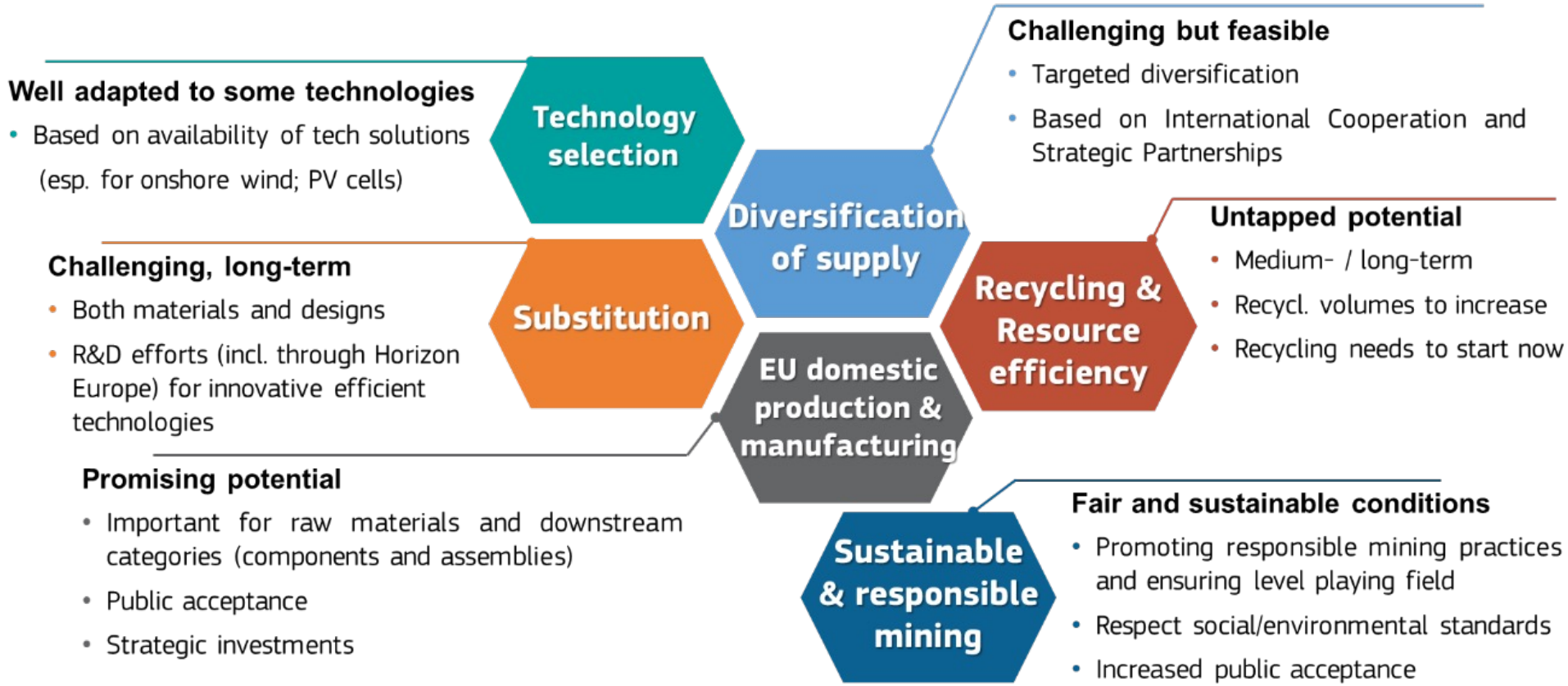
Raw Materials Foresight





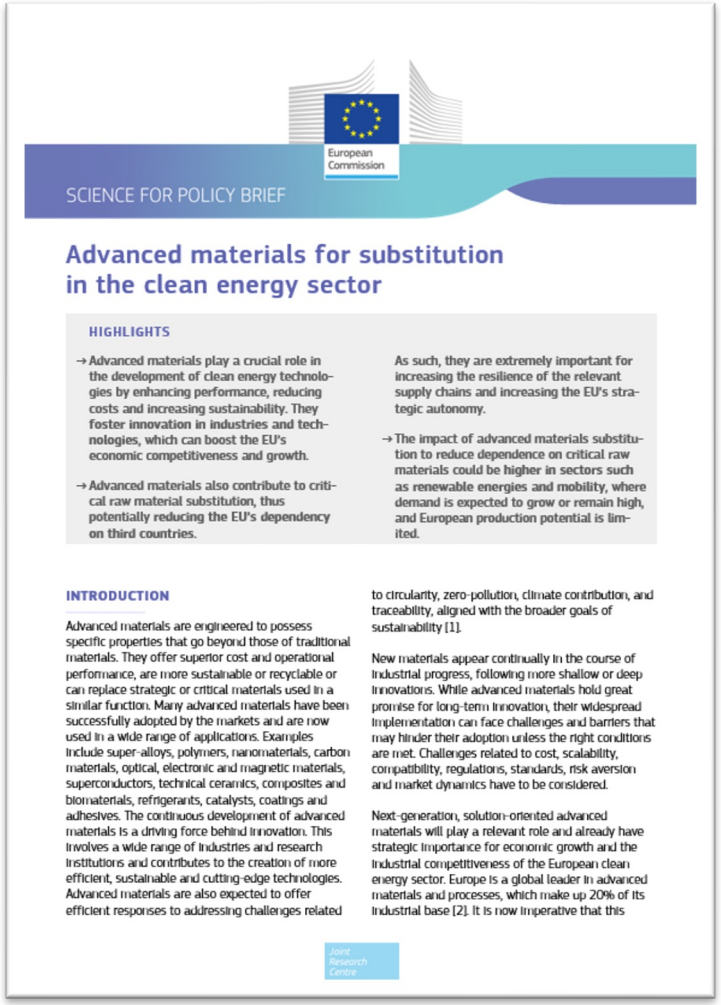
Objective: support policy making

Possible actions to increase resilience of supply chains



Advanced materials for substitution in the clean energy sector

- Advanced materials can contribute to CRM **substitution**, potentially reducing the EU dependency on third countries, making the relevant supply chains more resilient and increasing the EU strategic autonomy.
- Their impact could be particularly significant in sectors such as renewable energies and mobility, where demand is expected to grow while EU production potential is limited.
- Our recent **Science for policy Brief** reviews how advanced materials can contribute to **decrease the use of CRMs** in clean energy technologies
- Full report: Autumn 2024



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SCIENCE FOR POLICY BRIEF

Advanced materials for substitution in the clean energy sector

HIGHLIGHTS

→ Advanced materials play a crucial role in the development of clean energy technologies by enhancing performance, reducing costs and increasing sustainability. They foster innovation in industries and technologies, which can boost the EU's economic competitiveness and growth.

→ Advanced materials also contribute to critical raw material substitution, thus potentially reducing the EU's dependency on third countries. As such, they are extremely important for increasing the resilience of the relevant supply chains and increasing the EU's strategic autonomy.

→ The impact of advanced materials substitution to reduce dependence on critical raw materials could be higher in sectors such as renewable energies and mobility, where demand is expected to grow or remain high, and European production potential is limited.

INTRODUCTION

Advanced materials are engineered to possess specific properties that go beyond those of traditional materials. They offer superior cost and operational performance, are more sustainable or recyclable or can replace strategic or critical materials used in a similar function. Many advanced materials have been successfully adopted by the markets and are now used in a wide range of applications. Examples include super-alloys, polymers, nanomaterials, carbon materials, optical, electronic and magnetic materials, superconductors, technical ceramics, composites and biomaterials, refrigerants, catalysts, coatings and adhesives. The continuous development of advanced materials is a driving force behind innovation. This involves a wide range of industries and research institutions and contributes to the creation of more efficient, sustainable and cutting-edge technologies. Advanced materials are also expected to offer efficient responses to addressing challenges related to circularity, zero-pollution, climate contribution, and traceability, aligned with the broader goals of sustainability [1].

New materials appear continually in the course of industrial progress, following more shallow or deep innovations. While advanced materials hold great promise for long-term innovation, their widespread implementation can face challenges and barriers that may hinder their adoption unless the right conditions are met. Challenges related to cost, scalability, compatibility, regulations, standards, risk aversion and market dynamics have to be considered.

Next-generation, solution-oriented advanced materials will play a relevant role and already have strategic importance for economic growth and the industrial competitiveness of the European clean energy sector. Europe is a global leader in advanced materials and processes, which make up 20% of its industrial base [2]. It is now imperative that this

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Authors and collaborators

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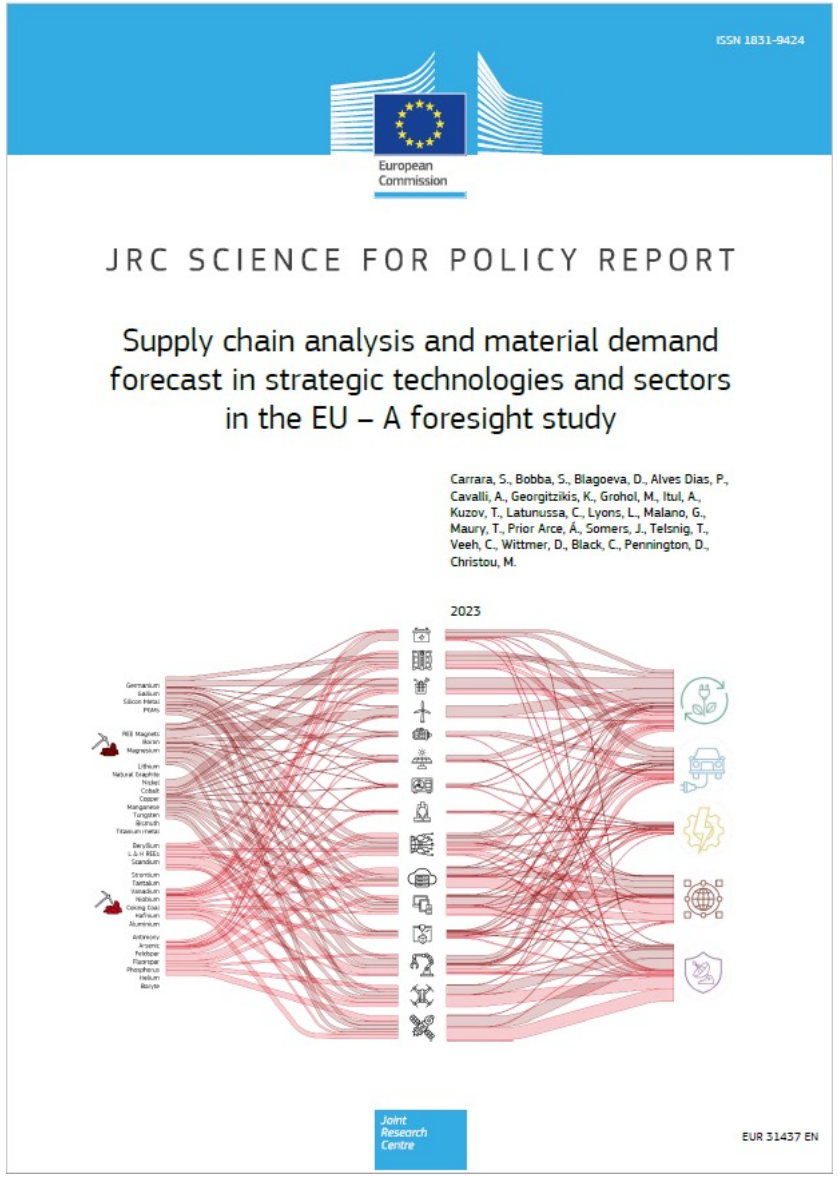

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and keep in touch

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