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How Dependent Is Germany on Raw Material Imports? An Analysis of Inputs to Produce Key Technologies

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Key Messages

- The production of key technologies such as electric motors, batteries and wind turbines is often dependent on imported raw materials.
- Using German data, we analyze important raw materials that are required to produce key technologies in Germany. We identify nine critical raw materials (1) with a high degree of supplier concentration and (2) which are used in the production of more than four key technologies.
- Except rare earths, Germany imports all critical raw materials from at least four of the top 5 exporters worldwide, which indicates a high diversification of sourcing. However, it is crucial to deepen existing trade relationships and to acquire new sourcing partners to increase resilience.
- China is among the top 5 exporters worldwide in seven out of the nine listed critical raw materials.
- We evaluate working conditions, environment, and democracy in the sourcing countries. Germany's sourcing countries score better than those of the US and China. However, raw materials such as boron or rare earths are often imported from countries that perform poorly in those categories.

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How Dependent Is Germany on Raw Material Imports? An Analysis of Inputs to Produce Key Technologies

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The Ukraine war and geopolitical tensions pose major challenges for supply chains. Whereas shortages of microchips became a symbol of supply chain disruptions during COVID-19, a survey from June 2022 from the ifo Institute shows that over 74% of German manufacturing firms report production disruptions due to shortages of different types of inputs and raw materials.

The production of key technologies that are necessary, for instance for the energy transition, often depends on imported raw materials. Therefore, it is important to evaluate Germany's raw material dependencies at the product level to identify the risk of future supply chain disruptions.

In a recent report (see Flach et al., 2022), we examine Germany's dependency on raw material imports that are necessary to produce the following key technologies: electric motors, wind turbines, photovoltaic technologies, 3D printing, robotics, digital technologies, drones, lithium-ion batteries and fuel cells, and hydrogen technologies.

Using trade data from Destatis – Germany's Federal Statistical Office, we identify nine **critical raw materials,** which have (1) a high degree of supplier concentration and (2) are used in more than half of the key technologies**.** For these raw materials, we provide a detailed analysis on Germany's dependency on imports (see Flach et al., 2022). Moreover, we employ indices of working conditions, democracy, and the environment to evaluate the conditions in the sourcing countries of raw materials. In the final part of the study, we discuss alternatives to increase the resilience of sourcing.

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Critical raw materials for the German economy

The European Commission (2020) defines 23 important raw materials that are required to produce the nine key technologies mentioned above. Based on this list, we define for the German economy raw materials with **critical dependencies** in terms of the market concentration of sourcing countries[1] and in terms of their usage as inputs to produce key technologies.

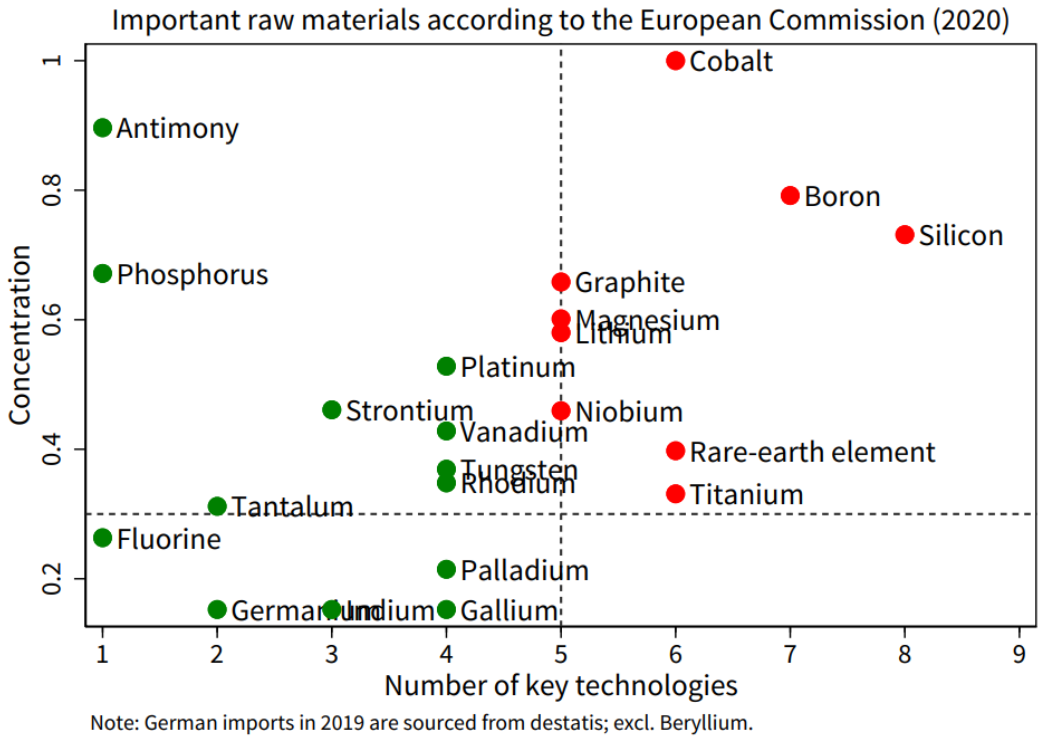
Figure 1 shows in the vertical axis the degree of market concentration of sourcing countries, whereby one means the highest concentration. The horizontal axis shows the number of technologies that employ a raw material as an input. As shown in **Figure 1**, important raw materials fall into three distinct groups. The **first group** includes raw materials with diversified sources and whose use is limited to a few key technologies.[2] The **second group** consists of raw materials that exhibit a high supplier concentration but are used in the production of only a few key technologies.[3] The **third group** includes raw materials which show both a high sourcing concentration and are also required to produce more than half of the key technologies. This third group of **critical raw materials** comprises the following nine raw materials shown in Table 1: cobalt, boron, silicon, graphite, magnesium, lithium, niobium, rare-earth elements, and titanium. These raw materials are essential, for instance for Germany's green technology transition, while at the same time they exhibit major dependencies on a few suppliers.

[1] To quantify the geographic concentration of sourcing countries, we calculate the Herfindahl-Hirschman-Index (HHI) for every raw material imported by Germany.

[2] Fluorine, germanium, indium gallium, palladium.

[3] Antimony, phosphorus, tantalum, strontium, platinum, vanadium, tungsten, rhodium.

Figure 1. Import concentration and usage of raw materials to produce key technologies



Note: Figure 1 shows important raw materials (22 excl. Beryllium) that are required to produce nine key technologies according to the European Commission (2020). The vertical axis shows the degree of concentration of sourcing countries, whereby 1 means the highest concentration of suppliers. The horizontal axis shows the number of technologies that require a raw material as input for the production. Nine critical raw materials are shown in red. The figure is based on product-level import data for the year 2019 from Destatis – Germany's Federal Statistical Office.

Detailed analysis of critical raw materials

Once we identify critical raw materials, we conduct a detailed analysis of sourcing countries and import dependencies for every critical raw material (details available at Flach et al, 2022). We compare Germany's imports with the world's exports and with available reserves worldwide to descriptively analyse the "untapped potential" of sourcing diversification.

Our analysis reveals that there exists **untapped potential for Germany to diversify** its sourcing of raw materials. Germany imports most of its critical raw materials from all major producers worldwide, which already indicates a high degree of diversification. However, trade relations with many partners could be intensified to reduce the remaining dependencies. Particularly in the case of **rare earths**, efforts ought to be made to

increase **diversification** of supplier countries: Germany sources rare earths from only two of the world's five largest exporters.

We show that the **European Union** (EU) member countries are important trading partners for Germany's raw material imports: Germany's imports of all critical raw materials from the EU are significantly higher than the EU's share in global exports.[4] This highlights the importance of strengthening **European cooperation** to ensure and improve access to raw materials without lowering environmental and social standards. The **"European Raw Materials Alliance"** launched by the EU in 2020 serves as a cornerstone for stepping up joint efforts within the EU. Particularly in times of crisis, the EU's market power is of great importance to ensure access to raw materials.

Geographic concentration of sourcing countries

China is among the world's top five exporters of seven of the nine critical raw materials listed above.[5] For lithium and niobium, **Latin American countries** are the major suppliers, while **Asian countries** are particularly crucial for the supply of rare-earth elements: Myanmar and Thailand are important producers alongside China, while Vietnam has vast untapped resources.

State of working conditions, environment and democracy in the sourcing countries

We use the following three indices to evaluate the conditions in the main sourcing countries of raw materials: (1) working conditions from the International Trade Union Confederation (2020), (2) democracy index from the Economist Intelligence Unit (2021), and (3) environmental performance index from Wendling et al. (2020). We then evaluate how German suppliers perform in terms of the different indices in comparison to US and Chinese suppliers.

Bor and rare earths are two examples of raw materials that are commonly sourced from countries with low working conditions: four out of five of the main exporters worldwide are classified as countries in which workers have no guarantee of rights.

Germany's suppliers score **better than** those of the USA and China when it comes to working conditions, democracy, and environmental protection. However, individual raw materials, such as boron or rare-earth elements, are often imported from countries that perform **poorly** in those categories.

[4] The high share from the EU may be partly due to re-exports.

[5] Boron, graphite, lithium, rare earths, cobalt, silicon, magnesium.

Alternatives to improve the resilience of supply chains

Strategic partnerships and the EU internal market

Besides strengthening **European** cooperation to improve access to raw materials as discussed above, strategic partnerships outside the EU also play a key role.

With about half of the non-EU countries that are major exporters of critical raw materials, Germany and the EU already have trade agreements. Germany imports more from these trade partners than it does from countries without preferential market access. Notably, for cobalt and titanium, Germany could expand trade relations with Australia, Indonesia and the US, which are among the top 5 exporters of these raw materials. Argentina and Brazil are among the top 5 exporters of lithium and niob, respectively. For the sake of **reducing trade costs**, the EU should intensify trade relations with these countries. In addition, the EU would be able to quickly and easily lower costs for domestic producers by eliminating existing tariffs on raw materials, which are on average 3.5%. Trade and investment agreements and **strategic partnerships** with further world regions could help firms diversify their sourcing strategy and facilitate market access.

Investments in technology

Investments in technology are crucial for the development of new environmentally friendly and innovative key technologies. It is up to policymakers to establish **appropriate general conditions**, such as simplified access to low-threshold funding programs for firms or the funding of research.

Circular economy

The expansion of the **circular economy** is another key aspect: first, the circular economy allows new raw materials to be tapped, namely secondary raw materials may be obtained through recycling. Second, the circular economy offers opportunities for the development of new business models. Here, the broader scope enables **sizeable efficiency gains** through **coordinated EU-wide funding** of research and development. Nonetheless, appropriate competition in the allocation of funding and research resources should be ensured.

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