European Commission

Science for Environment Policy

A new approach: Assessing the vulnerability of critical raw materials in the automotive industry

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Source: Knobloch, V., Zimmermann, T. and Gößling-Reisemann, S. (2018). From criticality to vulnerability of resource supply: The case of the automobile industry. *Resources, Conservation and Recycling*, 138, pp.272-282.

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In the automobile industry, the development and manufacture of increasingly complex technological components — catalytic converters, LEDs, electric motors, batteries — requires increasingly complex and diverse raw materials with specific qualities. The technological and economic importance of these materials, combined with their vulnerability to supply shortages and likelihood of supply interruptions, indicates their 'criticality'. This study uses a new methodology to explore the criticality of 27 key metals used in the automotive industry and other sectors, and highlights six that are especially vulnerable: rhodium, dysprosium, neodymium, terbium, europium and praseodymium. The researchers found there was limited recycling and substitution of these metals and a high possibility of restrictions to their supply[1].

Identifying a material's criticality can, crucially, reveal potential supply shortages, which then enable actions to mitigate the impact of these shortages — such as research on substitution, recycling, and material efficiency, or on how to extend a product's lifespan.

The European Commission maintains a regularly updated list of critical raw materials (CRMs) for the EU: those of high importance to the EU economy that also have high levels of risk associated with their supply. Previous studies have used parameters based on risk to determine criticality — however, this study instead uses a new methodology based on the concept of vulnerability, and applies this to the automotive industry. This industry is economically important in many countries and, to date, the criticality of metals used in car production has not been specifically assessed.

Vulnerability was defined using three sub dimensions: *sensitivity, exposure* and *adaptive capacity:*

- ***Sensitivity*** relates to the resource in question — its supply/demand structure, and how the system can influence this itself (influencing the amount of raw materials needed, for example, by changing the number of cars produced);
- ***Exposure*** indicates the potential degree and likelihood of supply changes that affect how a system fulfils its service, including research into possible future replacements. Together, sensitivity and exposure can potentially bring about damages that interfere with a system's ability to deliver its service without an appropriate adaption;
- ***Adaptive capacity***[2] comprises the system's ability to react to changing supply conditions — via substitution or recycling/reuse, for instance. When determining the potential substitution of the metals, the researchers used four indicators: the substitute performance; the substitute availability; the environmental impact ratio; and the commodity price.

These three dimensions were applied to 27 base, special, precious and rare earth metals used in car production. A score ranging from 0 to 1 was calculated for each metal for each dimension. For sensitivity, the annual registrations of passenger cars worldwide were ranked and examined alongside metal production and demand data; with both car bodies and other metal components considered. Exposure ranking included the present and future scarcity of raw materials, taking into account the production and extraction locations of companies and the situation in those locations. Adaptive capacity included aspects of substitution availability, cost and end-of-life recycling rate.

Continued on next page.

1. This finding is based on the data available and used at the time the study was prepared.

2. Adaptive capacity, or 'resilience', or other key elements, such as fast-growing demand, cannot be considered when drawing the CRM list for the EU.

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A new approach: Assessing the vulnerability of critical raw materials in the automotive industry *(continued)*

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Of the 27 metals, dysprosium, neodymium, terbium and europium (used in electric motors and automotive electronics) were some of the most vulnerable: they cannot be substituted or recycled, and are solely provided by China. The largest demand-to-production ratios were for rhodium, palladium, platinum and vanadium (used in catalytic converters and vehicle bodies). When the three sub-dimensions were amalgamated into a single vulnerability score, rhodium, dysprosium, neodymium, terbium, europium and praseodymium[3] (used in autocatalysts, electric motors and LED lighting) were the six most vulnerable metals in automotive production. Recycling and substitution were limited, and these metals saw high exposure to potential restrictions on supply.

These findings highlight six metal CRMs — rhodium, dysprosium, neodymium, terbium, europium and praseodymium — that are represented within material groups (heavy rare earths, light rare earths and platinum group metals) in the EU's 2017 list of 27 CRMs. However, the criteria used in this methodology differ from those used by the EU, and consider a global, rather than a solely European, perspective[4]. The researchers assert that applying this methodology could provide insight into the need for alternative material development and new assembly technologies within the automotive industry as well as other sectors that utilise CRMs.

3. In the EU's 2017 list of 27 CRMS, these six do not appear as individual metals but as part of material groups — heavy rare earths, light rare earths and platinum group metals.

4. More research is needed on the materials' issues for next-generation cars, such as electric vehicles, in particular vis-à-vis the manufacture of batteries.