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Metallic raw materials – the building blocks of the circular economy

Disrupted supply chains during the Covid pandemic and the dependencies on countries such as China have placed the issue of secure raw material supplies on the agenda. The war in Ukraine and the resulting economic sanctions against Russia have additionally fuelled the debate about supply security and the circular economy. As the world's leading communication platform, the Bright World of Metals in Düsseldorf from 12 to 16 June 2023 will move these hot topics centre stage.

Steel and steel raw materials are also subject to the sanctions imposed against Russia by the EU. Step by step the sanctions were extended to include all steel products, and even imports of Russian steel into the EU via third markets are prohibited. Nevertheless, the results are sobering from the German steel industry's perspective. The Wirtschaftsvereinigung Stahl (German Steel Federation) laments that some EU member states pushed ahead with very long transition periods until October 2024 in the very relevant segment of so-called semi-finished steel products. This means Russian steel imports into the EU will hardly change in the near future. While, after the fourth sanctions package was adopted on 15 March 2022, 52% of Russian steel supplies were still admissible (compared with imports in 2021), this figure is still as high as 47% even after the by now ninth sanctions package. With the exception of gas and oil the EU sanctions against Russia are hardly perceivable in raw material supplies. Critical raw materials had been largely excluded from the sanctions anyway, and for the German steel industry Russia had only been an important supplier of such raw materials as coal and alloying materials. In the wake of the sanctions companies have re-oriented their raw material purchases to other sources.

Powerful Russian metal suppliers such as aluminium producer Rusal and nickel supplier Norilsk Nickel, Nornickel for short, are not affected by these sanctions anyway, so that Europe continues importing metals such as nickel, copper and aluminium from Russia on a large scale. Lobbyists such as the Federation of Aluminium Consumers in Europe (FACE) have

complained about the market power of the major European producers for years and have successfully spoken up against import restrictions on Russian aluminium. Rusal is the largest Russian aluminium producer, ranking third on the world market after the Chinese producers Chalco (number 1) and Hongqiao. Nornickel is the world's largest nickel and palladium producer.

Market power China

The geopolitical relevance of economic interdependencies must be put to the acid test, including against the backdrop of the war in Ukraine and the associated economic sanctions against Russia, demands the Wirtschaftsinstitut IW in Cologne. The Institute is concerned above all about China's market power: the system competitor, they say, is turning into a system rival. In a current study the IW therefore issues a warning about Germany's (and the RoW's) dependency when it comes to critical raw materials. At over 50% the percentage of Chinese exports into the world and Chinese imports into Germany is highest for magnesium, by IW accounts. China is the world's largest magnesium exporter. Regarding rare earths, indispensable for the expansion of renewable energies, Germany depends on Chinese supplies for 45% of its demand. "On its way to becoming independent of Russian energy carriers Germany might become newly dependent on China", the Institute warns.

E-mobility increases dependency on raw materials

By banking on e-mobility Germany is increasing its dependency on Chinese raw materials even further. China mines and processes to the tune of 87% of the world's rare earth deposits and up to 65% of such metals as cobalt, copper, lithium and nickel, calculates the Federation of SME Mineral Oil Companies (UNITI). These are the raw materials, however, that are needed in large quantities for expanding e-mobility. Depending on their battery size, e-vehicles contain up to 70 kg of cobalt, 13.5 kg of lithium and 80 kg of copper. Add to this large amounts of copper for expanding the charging infrastructure. More than half of all the raw materials required for electric motors hail from China.

EU Action Plan on Critical Raw Materials

The European Commission has identified this problem and addressed it with an Action Plan. The economically most important raw materials with high supply risk are categorized as critical raw materials, including raw materials needed for green and digital transformation technologies. Featured on the list of 30 raw materials rated as critical by the EU are, next to metals such as magnesium and titanium, the alloying elements vanadium and graphite important for steel production. Recently the list of critical raw materials has also included bauxite, the aluminium ore indispensable to the production of primary aluminium. According to the Deutsche Rohstoffagentur the biggest bauxite producers are Australia, China and Guinea, while the biggest primary aluminium producers are China, Russia, Canada and India. Also mentioned as an alloy for aluminium on the EU list is silicon and scandium, in demand for additive manufacturing of high-performance alloys.

With a new Act on Critical Raw Materials the EU intends to promote strategic projects designed to strengthen supply chains and conserve competition at the same time. The draft law covers the various levels of the supply chain from mining and processing to recycling. Measures include geopolitical raw material partnerships with such countries as Namibia and Kazakhstan. They aim at the sustainable mining of raw materials such as rare earths, polysilicon, lithium and cobalt, especially in Kazakhstan – raw materials required for manufacturing wind turbines, semi-conductors and batteries for e-vehicles. With the planned law the EU Commission also envisages various measures to reduce the dependency on raw material imports from third countries. One objective is to leverage the know-how acquired in European mining regions to tap into domestic raw material deposits.

Focus on the circular economy

A crucial element of the planned law – according to the will of the EU Commission – are incentives for the development of a circular economy with resilient supply chains, a market that offers new business opportunities for steel companies and foundries, metal processors, and metallurgical plant builders. New processes for the mining and reuse of valuable raw materials derived from electronic scrap and batteries complement the

classic recycling of metals ranging from aluminium to zinc. It's a market with future potential: according to a new study by IW Cologne (Institute of German Business) the smartphones discarded in German households alone would suffice to cover the raw material demand for new smartphones for ten years.

The leading metallurgical plant manufacturer SMS Group has identified the market potential of urban mining and initiated Primobius, a joint venture with the Australian Neometals company for recycling lithium-ion batteries. The pilot plant at SMS's Hilchenbach site serves to reclaim cobalt, nickel, copper, lithium, iron, aluminium, carbon, plastics and manganese and to convert them into marketable products for use in the battery supply chain. With this pilot plant the plant manufacturer intends to reclaim 96% of rare raw materials from car batteries hydro-metallurgically for the first time. This process had so far not been possible. Until now battery components had to be disposed of in landfills or processed in high-emission pyrometallurgical reclamation cycles.

Primobius already succeeded in winning over first interested parties for its know-how. Mercedes Benz announced the installation of their own CO_2-neutral recycling factory for e-vehicle batteries by means of their recycling start-up Licular at the Kuppenheim site. The pilot project initiated with technology partner Primobius and research institutes is to go live in 2023. According to Production Manager Jörg Burzer Mercedes-Benz pursues the aim of maximum circularity for all raw materials used, and sustainable battery recycling, he says, plays a crucial part in this.

Automotive industry drives forward the circular economy in the metal industries

From recycling aluminium for e-vehicles and battery reclamation to low-emission steel in car bodies: decarbonisation, sustainability and a circular economy play an ever-greater role in the automotive industry. This means carmakers become the drivers of green technologies for metal sectors from steel mills to foundries.

BMW, for example, has established closed-loop recycling for production scrap from casting processes at its light metal foundry in Landshut in cooperation with local recyclers. A crucial prerequisite for this is the clean-

grade sorting of aluminium scrap. To this end the residuals of the various components are collected at each casting line as well as at the various mechanical finishing stations in such a way that the materials with their individual compositions are not mixed. After re-working this aluminium scrap can be used for producing the same components. Almost half of the aluminium used in Landshut stems from closed-loop recycling. This allows BMW to reduce the use of CO_2-intensive primary aluminium for the benefit of a CO_2-optimised recycling.

Volkswagen has sourced its steel from what is called Salzgitter AG today for 60 years now and is one of the first buyers of low-CO_2 steel, which the steel group wants to produce at its Lower Saxony headquarters from late 2025. At the same time, the companies have established a closed loop for their recyclables between their factories in Wolfsburg and Salzgitter: by train the sheet steel coils are supplied to the automotive manufacturing site in Wolfsburg. On the return trip the train takes the production scrap back to Salzgitter, where it is processed into clean-grade products of the same quality and delivered to VW.

The circular economy is not limited to improved recycling rates, as the Fraunhofer Gesellschaft illustrates in its Circonomy research approach. The optimal use of raw materials, they say, comprises an extension of the useful life of components and raw materials plus the lowest possible use of external additives and energy as well as the lowest production waste output possible. The solution is a connected and digitised closed loop, as stressed by Franz-Josef Wöstmann, head of the Department for the Early Detection of Technologies and Their Use at the Fraunhofer Institute for Manufacturing Technology and Advanced Materials (IFAM) in Bremen.

Circular component design as a business model

The product lifecycle should ideally focus on re-use rather than scrapping. The aim should be to keep not only as much raw material but also as many components as possible in the cycle. “If I break down a battery housing of an e-vehicle into its individual components and melt them down I still have to invest a lot of energy”, Wöstmann says, raising a point of concern. If, on the contrary, the battery tray and the housing of the power electronics are re-used for the next generation, this energy is not required to start with.

“The basic requirement for this is a cross-generational vehicle design”, the Fraunhofer expert claims.

For a truly circular component design raw materials would have to be standardised. For battery trays, for example, only two instead of 12 different casting and forging alloys should be used, which can later be processed both by casting and forging. The manufacturers of cars or refrigerators, in turn, should know which materials are currently “moving in the cycle” and when their fridges or cars will come back. This requires both the digitalisation of materials flows and components streams and the definition of standards for cross-sectoral raw material circularity, such as for drive train components in e-vehicles. Wöstmann sees quite an opportunity for upstream suppliers here. Components with a lower CO_2 balance which can be re-used in the next product generation would have a USP for buyers. Wöstmann is confident: “This will make the circular economy a profitable business model.”

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