Better recycling of Critical raw materials

Summary of report, August 2022

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A NORWEGIAN PERSPECTIVE ON CRITICAL RAW MATERIALS

Norway is dependent on a number of critical raw materials to be able to digitize and electrify our society at the same time as we create new industry and new jobs. This summary is taken from the report *Better recycling of critical raw materials*, which aims to contribute to a fact-based debate about how we as a society should ensure future growth and welfare. A request for the full report can be filed at https://renas.no/kritiske-ramaterialer/.

The report provides an overview of critical raw materials and describes why these are so important. The report also provides an insight into the supply challenges associated with these raw materials – and presents concrete advice on how we can build more robust supply lines in the future. We believe the report is important because it helps to close a knowledge gap in an area with high political and economic risk, but which can also give us great opportunities. Sharing knowledge is a rule of life at RENAS because we are convinced that no single actor can solve the challenges of the future alone. Therefore, we must increase our common knowledge bank to ensure best possible handling of risks and exploitation of opportunities.

We hope the report receives considerable national attention - also because the geopolitical situation is more precarious than it has been for many years. Norway is dependent on critical raw materials from states in conflict and states that show great willingness to use their market power to gain increased political influence.

EU has for a long time maintained an overview of the need for critical raw materials because Europe wants supply security, a secure economy and geopolitical control. We will also benefit from doing the same in Norway. Such a survey would give us the opportunity to assess our own vulnerability, develop the recycling industry so that it can deal with the real raw material challenge and create new industry. Control over these value chains is essential to ensure a sustainable society and industry risk reduction.

This report is a contribution to the ongoing work of building a more active policy for critical raw materials. Our hope is that the report will be read by politicians, industry leaders, members of academia and everyone else who is concerned with how to create a safer and more sustainable Norwegian economy.

Bjørn Arild Thon
CEO RENAS AS

CRITICAL RAW MATERIALS

– "stuff you need but can not always get"

Critical raw materials are elements and chemical compounds that have numerous and important areas of use, and which are also associated with a particularly high supply risk. If the needs for such raw materials cannot be met, industry that uses them could come to a halt, and important social functions that depend on them may be damaged or come to an end. Examples of critical raw materials are phosphorus in the form of phosphate (necessary for all plant growth and food production), lithium (necessary for battery production), gallium (necessary for the production of LED light bulbs) and rare earth metals (necessary for electrical products and permanent magnets). Growing populations and economies increase the pressure on more and more deposits of elements with limited availability. In addition, there are technological changes such as digital- and green transitions, which create a need for further supply of many of the same raw materials. Taken together, these trends are expected to lead to an increase in consumption of many critical raw materials in the order of 10–100 times in the coming years compared to the global consumption today.

AVAILABILITY COMPARED TO NEEDS

Virtually all 90 elements found in the earth's crust have applications as material input factors in the production of various goods and services in a modern society, some more than others. The abundance of various elements in the earth's crust is highly variable. For many elements that have a large global consumption, worryingly small known remaining geological reserves exist. In addition, many elements are unevenly distributed on the Earth's surface, and some are only available for extraction in countries with unstable or protectionist governance regimes that represent an additional significant supply risk.

Figure 1. Total consumption of critical raw materials in the world.
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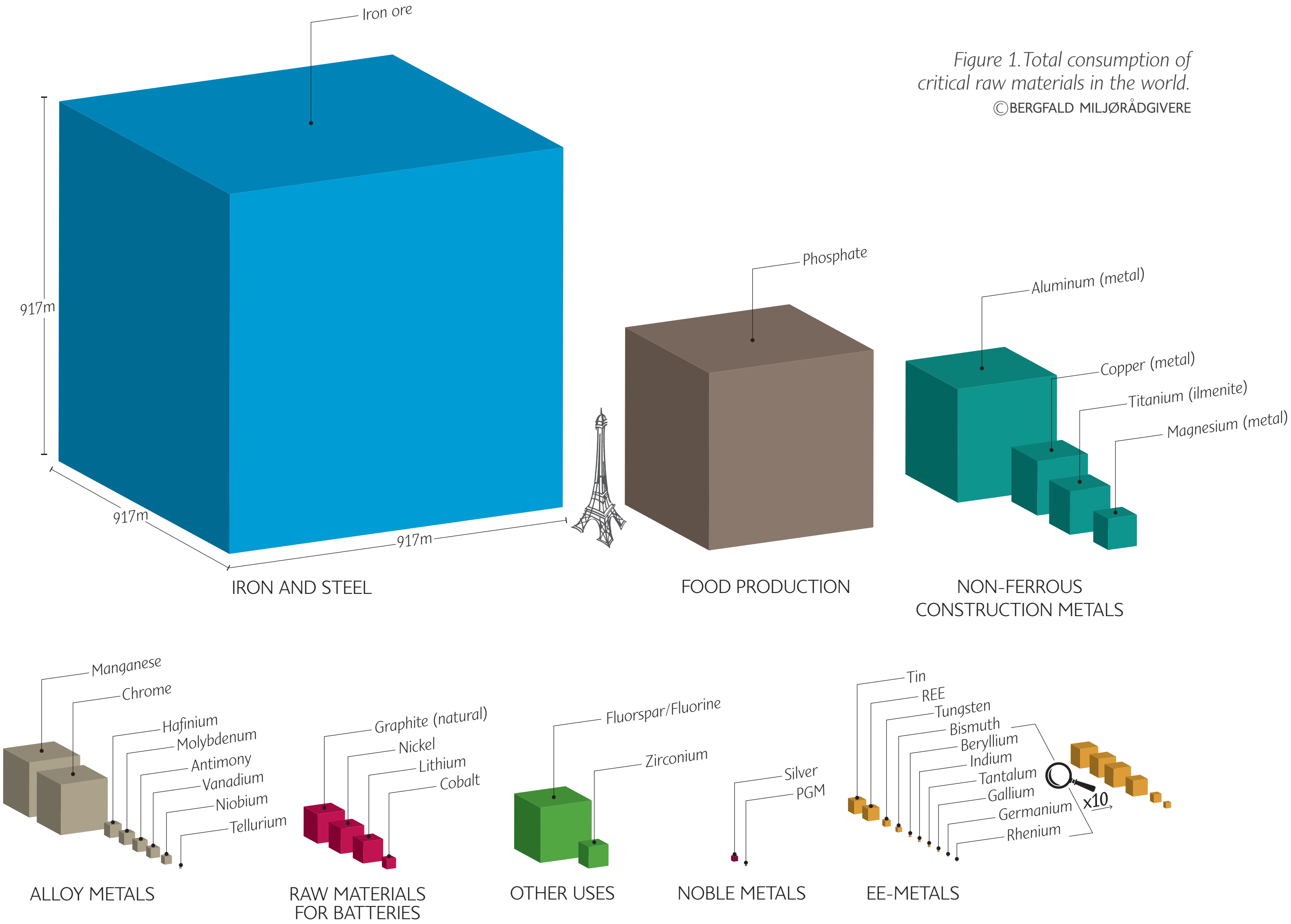

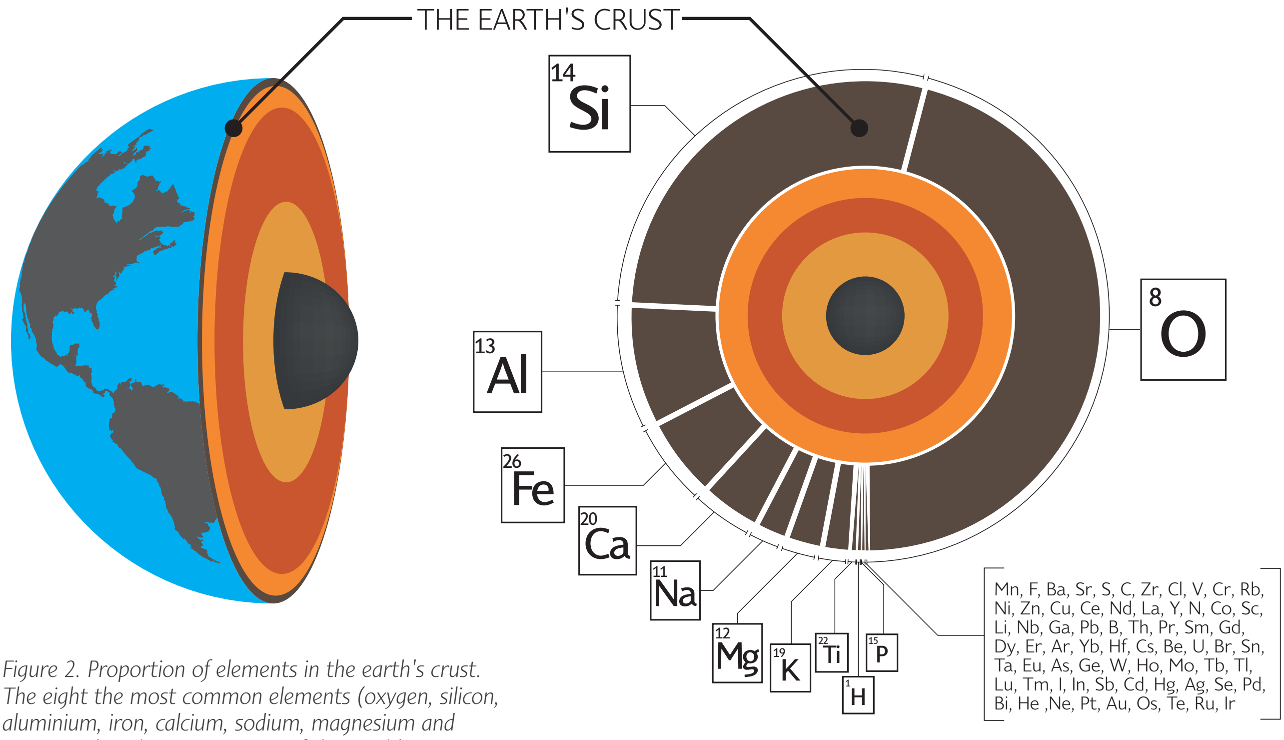

Figure 2. Proportion of elements in the earth's crust. The eight the most common elements (oxygen, silicon, aluminium, iron, calcium, sodium, magnesium and potassium) make up over 99% of the earth's crust, while the other 82 the elements make up less than 1%.

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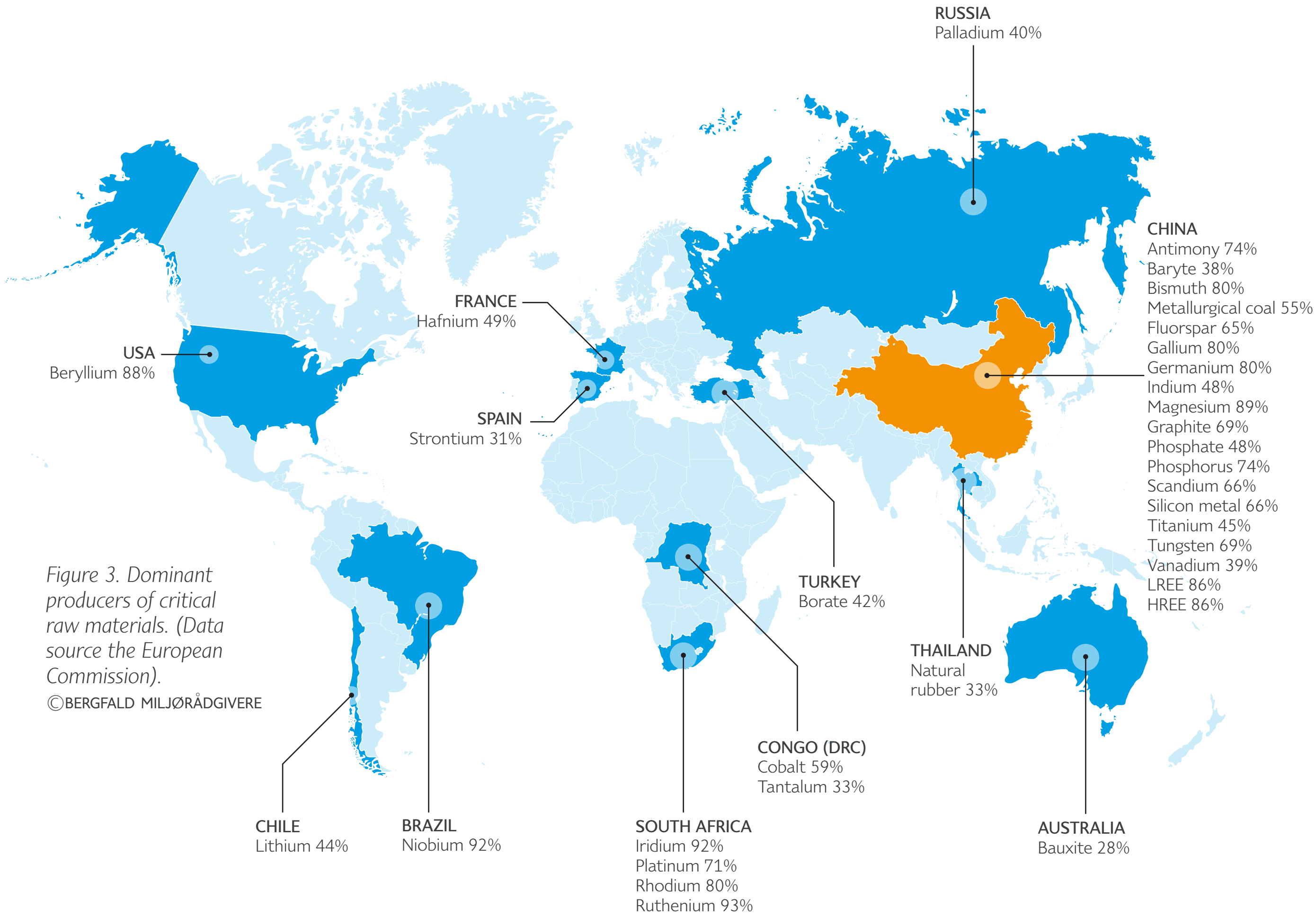

Figure 3. Dominant producers of critical raw materials. (Data source the European Commission).

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POLITICAL STRATEGIES FOR REDUCED SUPPLY RISKS FOR CRITICAL RAW MATERIALS

Because a modern society completely depends on critical raw materials in order to function, many states have developed political strategies to reduce the supply risks. These strategies often include lists of the raw materials that are considered critical. The EU published its first list of critical raw materials in 2011 and has since revised this list every three years, with its last revision in 2020. Figure 6 shows an overview of the raw materials included in the EU's list of critical raw materials as of 2022. The EU's list also contains a small number of raw materials that are not chemical elements, for example rubber. Some elements are represented on the list by the minerals they are extracted from, for example bauxite (aluminium) and fluorspar (fluorine). Political strategies for reduced supply risks for critical raw materials will normally contain measures that support value chains for both primary and secondary production of these raw materials.

Value chains for primary production are based on virgin mineral ore resources, and strategic measures towards these value chains often involve efforts to ensure necessary access to central mineral deposits and industrial capacity that can process the ore resources forward to final refined raw material products. A challenge often associated with the primary production of many elements is that they are only produced as by-products together with other elements. This results in increased supply risk due to the fact that that reduced production of the main product will also result in a corresponding reduced production of the by-products. For the same reason it is also difficult to increase the extraction of the by-products, if demand increases more for these than for the main product. Examples of critical elements and raw materials that are only produced as by-products are helium, indium, gallium, germanium, rhenium, selenium and tellurium. Another challenge is that in an increasing number of countries there is a declining societal acceptance of mineral extraction in the local areas where minerals are available, which makes it very demanding to expand primary production of many critical raw materials.

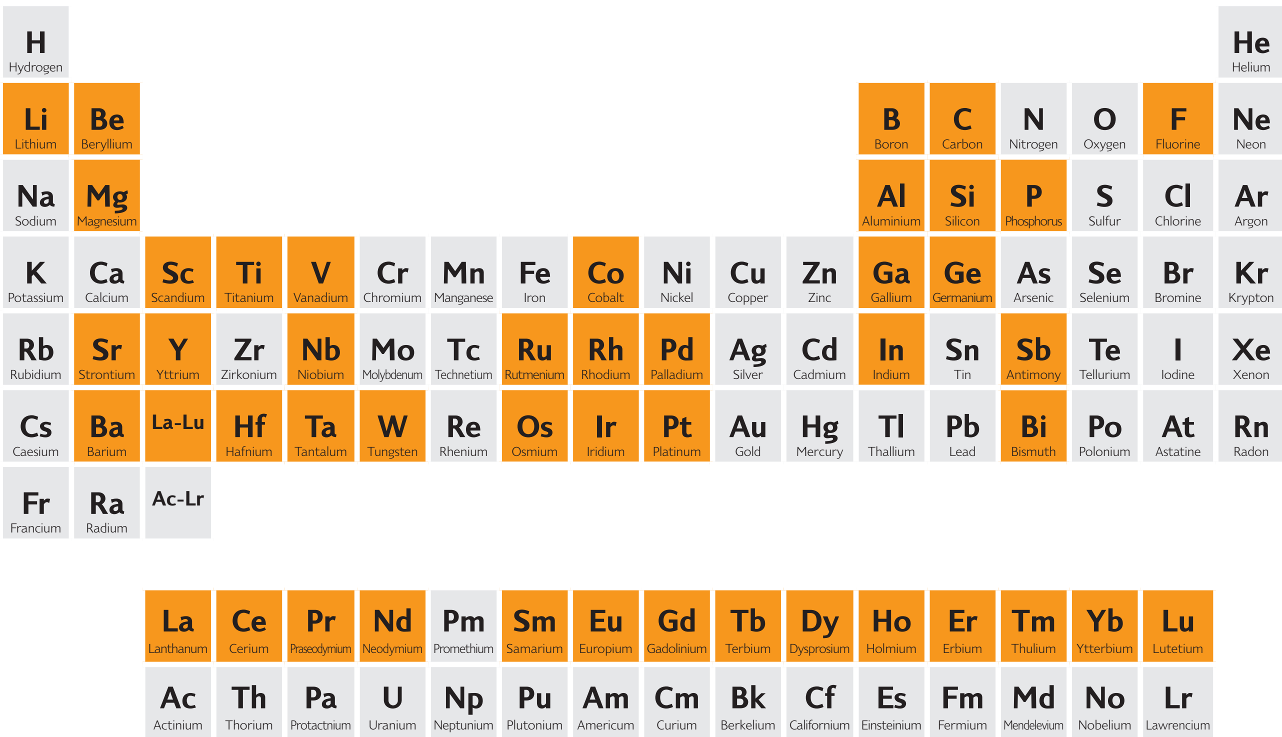

Figure 4. Overview of elements listed as critical raw materials by the EU as of 2022. ©BERGFALD MILJØRÅDGIVERE

Secondary value chains supply the same raw materials based on recycling from discarded products and sorted waste streams. For this reason, there is a close link between strategies for critical raw materials and the circular economy. A crucial step in a secondary value chain for critical raw materials is a well-functioning collection system that ensures that a high proportion of existing waste raw material is made available for recycling. Because collected waste normally consists of mixtures of different materials, sorting solutions are also required that enable the separation of relevant material streams that are necessary for profitable and resource-efficient recycling. Although the concept of circular economy is receiving increased attention, as of 2022, there are still many critical raw materials where the recycling rate is practically zero. This is partly due to high recycling costs compared to the sales value of the products but also because for many critical elements there are no mature and cost-effective technologies for sorting and recycling available. For this reason, there is, for example, no real recycling of gallium that is used in all led lighting, indium which is used in touchscreens and rare earth metals which are used in electronics, electric cars and wind turbines. Even for basic metals for which there are available recycling solutions, such as for aluminium, tin and tungsten, the recycling rate is far lower than it could and should be. Technology development will eventually lead to more resource and cost-effective recycling solutions that also enable the recycling of more critical raw materials. However, this will require considerable R&D efforts. Interesting technology concepts that are expected to be central in this development include biosorption and supercritical fluid extraction. Figure 5 shows important stages in the product life cycle of primary and secondary raw materials.

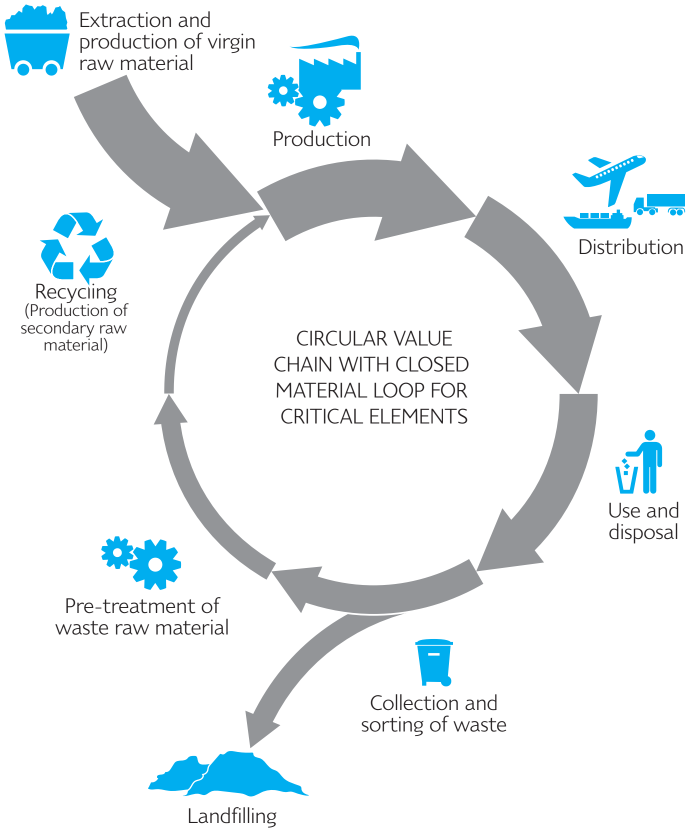

Figure 5. Stages in the life cycle of primary and secondary raw materials and the products they are part of.
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Figure 6. Critical raw materials have so far received little attention in Norwegian politics and is only mentioned sporadically in central planning documents for waste policies and circular economy.

Despite the increasing attention that critical raw materials have attracted in many other countries, there has so far been little interest and attention to this important topic in Norway. Despite the close link that exists between the supply risks for critical raw materials and the circular economy, critical raw materials are, for example, only mentioned very briefly in national plans and strategies for waste and the circular economy, and no measures for reducing supply risks are discussed for raw materials other than phosphorus. This means that as of 2022, Norway has no independent policy regarding critical raw materials, and has only implemented measures that come from the EU through the EEA Agreement. Absence of Norwegian attention to critical raw materials stands in stark contrast to the political debate this topic has created in the EU where the war in Ukraine has created completely new and very demanding delivery challenges for several critical raw materials.

MANY CRITICAL RAW MATERIALS ARE USED IN EE PRODUCTS

Because a complete review of all areas of use for critical raw materials would be very extensive, the discussions in the report to which this document refers are limited to electrical and electronic products (EE products). The production of EE products requires many different elements. For example, 74 of the 90 elements found in the earth's crust are used in the production of circuit boards. For the same reason, discarded EE products are also of particular interest as a source for recycling these raw materials.

The consumption of EE products has increased sharply in recent years, and the growth is expected to continue in the future. In addition, a massive deployment of new infrastructure for the production and distribution of renewable electricity based on solar and wind is taking place, together with the electrification of the transport sector and industry. Altogether, this will require a large increase in the current consumption of many critical raw materials and sustainable management of these material resources requires the establishment of closed technical loops where the raw materials in discarded products and decommissioned infrastructure are effectively recycled.

CIRCUIT BOARDS – A TROUBLED GOLD MINE

Circuit boards are an important component in many EE products and consist of a plastic sheet that is used for mounting electronic sub-components. The circuit boards hold the sub-components firmly and enable easy electrical interconnections between them. A review of many elemental analyses of circuit boards carried out as part of the work with this report shows that many critical elements are present at high levels in many circuit boards. However, most of these elements are lost when the circuit boards are recycled because current recycling processes focus one-sidedly on the extraction of gold and a few other elements of high economic value. Through better pre-treatment of discarded circuit boards and adjustment of current recycling processes it will be possible to recycle far more critical elements. Sorting and special recycling of individual components on the circuit boards will, among other things, enable the recycling of tantalum, germanium and niobium.

RAW MATERIALS THAT ARE NOT CRITICAL ARE RECYCLED, WHILE CRITICAL RAW MATERIALS ARE NOT RECYCLED – WHAT CAN BE DONE?

Increased resource utilization through more efficient collection, pre-treatment and recycling of waste containing critical materials is a crucial part of a strategy to reduce supply risks. The following measures are considered particularly important:

Specific recycling targets for critical materials

The current regulations should be changed for waste streams that contain elevated levels of critical materials so that each critical material in the waste for which there are recycling solutions is given an independent recycling target.

Landfill bans on critical materials

A ban on landfilling waste that contains critical materials above a given concentration should be considered. Alternatively, should marked cell disposal be required when landfilling such waste so that the waste can be easily excavated when there are available recycling solutions for it.

Recycling requirements for EE waste from several areas of use

EE waste that is currently managed through separate channels, such as EE waste from rolling vehicles and machines on road and track, as well as sea vessels and aircrafts should no longer be exempt from the regulatory requirements for other EE waste. If necessary, separate EPR-scheme requirements should be considered for these sectors.

State guarantee for recycling facilities

Compared to mines, recycling plants have increased risks when it comes to access to raw materials. While a mine can map its geological resources in detail and plan with a long time horizon, recycling facilities are at the mercy of constant changes in what products are put on the market and what ends up in the waste. In order to increase recycling with more metals and ensure that the most important metals are also recycled, government minimum price guarantees should be considered, as is done in the agricultural sector with a target price for foodstuffs or in the energy market with contracts for difference.

A request for the full report can be filed at **https://renas.no/kritiske-ramaterialer/**

ABOUT RENAS: RENAS is Norway's leading WEEE compliance scheme. Through its 14 treatment facilities and 100 collectors across the country, RENAS takes care of the producer obligations of nearly 2,700 producers and importers of EE products. RENAS is a non-profit organization owned by The Norwegian Electrical Trade Association (EFO) and the trade association Elektro and Energy, part of the Federation of Norwegian Industries (Norsk Industri).

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