euromines

Implementation of the Action Plan on Critical Raw Materials

Euromines Position Paper

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Introduction

Euromines welcomed the Commission Communication "Critical Raw Materials Resilience: Charting a Path towards greater Security and Sustainability" (COM(2020)474 final). This document confirms the principles of the Raw Materials Initiative, launched in 2008 with the main objective of assure a sustainable and safe supply of mineral raw materials to the European industry and society, through three balanced pillars.

This communication includes an Action Plan where ten actions to diversify and strengthen Europe's raw materials supply are proposed. It also states that the Commission "intends to develop and implement these priority objectives and the action plan with the help of Member States and stakeholders, in particular the EIP Raw Materials and the Raw Materials Supply Group."

We must realize that the global population is expected to reach nine billion by 2030, including three billion new middle-class consumers. All of these have the right to secure their livelihoods and, if possible, increase their standards of living, as always in human civilization. This will increase demand for products and their related raw materials. In order to meet this challenge and to accomplish it with sustainably sourced raw materials, a shift towards more resource efficient production, increased recovery and reprocessing along the value chains and the end of life of products will be also important. Mineral raw materials will be decisive for a transition to a Low-Carbon society.

Increased need of all raw materials for the economic transition

(see Annex 1 and Annex 2 for statistics and more details)

A new report from the World Bank reveals significant forecasts for the European mineral raw materials industry. The report clearly demonstrates considerable increases in the production of minerals needed for clean energy technologies. Anticipated growth for minerals such as graphite, lithium and cobalt are as high as 500% by 2050. It also explains the absolute need for a wide range of minerals and metals for implementing renewable energy strategies and their related infrastructure, also providing an enlightened explanation about why recycling and reuse will not sufficiently meet demand, even when their rates are dramatically enlarged. The report reveals that some minerals, like copper and molybdenum, will be used in a range of technologies, whereas others, such as graphite and lithium, may be needed for just one technology: battery storage. This means that any changes in clean energy technology deployments could have significant consequences on the demand scenario for certain minerals.

Leveraging value chains' sustainability

It is also worth mentioning that the economic importance of the raw materials sector goes far beyond the sector's own economic activities. Whilst engaging about 350.000 direct jobs within the EU, there are more

than 24.6 million jobs in downstream manufacturing industries depend on the secure supply of raw materials. Raw materials depending industries in the EU provided 206 billion EUR of added value[1].

European mining companies have regularly taken measures to reduce mining related emissions, such as investing in alternative electricity generation and supply or switching to renewable energy sources for their electricity supply.

Most major mines in Europe are heavily investing in electrification and remote operation of their internal transportation, transport lines and machinery including investments in battery technology, electric mine trucks, electric trolley lines, electric conveyor belts and transport routes. Together with its equipment suppliers and downstream customers, the mining industry is investing in new and further research in developing raw material feeds that will allow reduction in carbon emissions in further processing. For example, Europe is leading the international mining and steel industries' search for new reduction processes with the aim of making steel with no carbon emissions whatsoever.

European mineral products also trigger emission reductions in other sectors of the economy. For example, new infrastructure for alternative energies requires increased use of metals and minerals, in particular steel for pipelines and mining equipment, copper and graphite for electricity cables, generators and electric motors, aluminium, primarily for electricity cables, and a host of other metals and minerals including phosphorous, potassium and nitrogen for biomass production. As an example, producing a 3-megawatt wind turbine may require 335 tonnes of steel, 4.7 tonnes of copper, 1,200 tonnes of concrete, 3 tonnes of aluminium, 2 tonnes of rare earth elements as well as zinc[2]. This illustrates the volume of raw materials needed for the green transition.

Solar photovoltaic panels and thermal systems use a combination of up to 22 non-ferrous metals, silicon, chemicals (e.g. organic electrolytes) and a specific type of flat glass. Improvements in solar energy cells are shifting some of the materials needed, and now include gallium arsenide, gallium indium phosphide and germanium. Besides these elements, solar panels may also contain molybdenum, zinc, cadmium, sulphur and aluminium.

Metals and minerals are essential for manufacturing any renewable energy supply technologies. Low-carbon technologies require significant amounts of steel, iron, copper, aluminium, zinc, nickel etc. as well as a vast array of speciality metals. In most cases, the annual demand for raw materials used in certain low-carbon technologies is projected to increase significantly by 2030.

When determining the contribution brought by a specific economic activity, three strategic segments should be addressed simultaneously:

- the sustainable supply of the raw materials needed to support the economic activity;

[1] Raw Materials Scoreboard, European Innovation Partnership on Raw Materials, European Union, 2018
[2] Race for lithium illustrates EU drive for 'strategic' raw materials, Euractiv quoting Maroš Šefčovič, the European Commission vice-president, 2018

- the contribution of other activities upstream and downstream; and
- the closure of associated material loops (the shift from linear to circular thinking).

Only through an integrated value chain approach can real advances in climate change mitigation be understood, achieved and evaluated over a longer-term horizon.

As mentioned above, to satisfy the current and future demand of raw materials by the EU industry, both primary and secondary production of raw materials must coexist.

The Ten actions to make Europe's raw materials supply more secure and sustainable:

1. Launch an industry-driven European Raw Materials Alliance
2. Develop sustainable financing criteria for the mining and extractive sectors
3. Launch research and innovation on waste processing, advanced materials and substitution of critical raw materials
4. Map the potential supply of secondary critical raw materials in Europe and identify viable recovery projects
5. Identify priority mining and processing projects for critical raw materials in the EU
6. Develop expertise and skills in mining, extraction and processing in regions in transition
7. Deploy Earth-observation programs and remote sensing for resource exploration, operations and post-closure environmental management
8. Develop research and innovation projects to reduce environmental impacts of raw materials extraction and processing
9. Develop strategic international partnerships to secure a diversified supply of sustainable critical raw materials, starting with pilot partnerships with Canada, interested countries in Africa and the EU's neighbourhood in 2021
10. Promote responsible mining practices for critical raw materials

Action 1 – Launch an industry-driven European Raw Materials Alliance

Launch an industry-driven European Raw Materials Alliance (ERMA) in Q3 2020, initially to build resilience and open strategic autonomy for the rare earths and magnets value chain, before extending to other raw material areas.

(please see attached documents for more details / value chain)

The European Commission has recently implemented the industrial ecosystem approach by identifying a total of 14 industrial ecosystems considered as strategically important for the EU Industry. In the frame of this approach, the Commission has proceeded to map the key value chains and their players for each industrial ecosystem, many of which tend to overlap.

In this context, ERMA should take advantage of the exercise conducted by the Commission to identify and prioritise those CRMs and raw materials that cover a substantial role in the highest number of value chains across the 14 industrial ecosystems and feature high supply risk scores. ERMA should subsequently assess those raw materials with high supply risks considered strategically important for a specific industrial ecosystem.

In the frame of the assessment of the materials, ERMA and its members should develop innovative and cutting-edge technology solutions designed in such a way to be easily adapted to address the specific needs, challenges as well as synergies between the different pivotal raw materials in the identified industrial ecosystems.

Action 2 – Develop sustainable financing criteria for the mining and extractive sectors

Develop sustainable financing criteria for the mining, extractive and processing sectors in Delegated Acts on Taxonomy by end 2021.

The European mineral raw materials industry enabling SDGs

The European mineral raw materials industry contributes to sustainable development by integrating economic growth with environmental protection, social progress, and effective governance. The European mineral raw materials industry supports the 17 goals laid out by the United Nations in its sustainable development agenda to end poverty, protect the planet and ensure prosperity for all, and is committed to their fulfilment.

The European mineral raw materials industry sector is among the most sophisticated of partners in addressing a range of sustainable development challenges. Mining companies are working to share their experiences more broadly and encourage further engagement in partnerships to achieve collaborative progress on the SDGs.

The European mineral raw materials industry contributes to ECONOMIC SUSTAINABILITY by:

- Staying financially strong and being an innovative and responsible sector contributing to prosperity.
- Maintaining high returns on equity.
- Having a healthy net debt/equity ratio.

- Consistently reporting results.
- Maintaining high ordinary dividends.

The European mineral raw materials industry contributes to SOCIAL SUSTAINABILITY by:

- Maintaining secure and attractive workplaces and exerting positive influences on our business partners and our immediate environment.
- Reducing accidents.
- Working to improve gender equality.
- Working to increase diversity.

The European mineral raw materials industry contributes to ENVIRONMENTAL SUSTAINABILITY by:

- Being resource-efficient and environmentally efficient.
- Reducing carbon emissions.
- Reducing energy intensity.
- Reducing discharges to water.
- Reducing emissions to air.

Understanding communities

It is impossible to relocate any mineral deposit. This fact determines the corporate citizenship profile of many mining and minerals companies everywhere in the world. From the very start of a project, companies in Europe work with local communities that will be directly affected by the endeavour and strive to work together with community members to develop strategies for long-term sustainability. The goal is always to foster suitable levels of trust and a fruitful working relationship that is mutually beneficial for both the people who live in the area and the company producing raw materials.

Social responsibility has been and is part of any sustainable operation program of all our member companies. Today, companies have an active role and heavily invest in improvements of the environment and quality of life, preserving traditions as well as rendering assistance in cases of natural disasters. In some regions of the EU, they are the only source of employment and wealth. The professionals who manage these projects are the companies' ambassadors in these local communities.

Sustainable Communities

The industry contributes to sustainable cities by supporting development of infrastructure, involving all stakeholders in land use planning, reclaiming affected land, for example into green spaces or heritage sites, and by producing innovative products such as concrete with higher CO2 capture or more durable steel. As in

the past, it is impossible today and, in the future, to have sustainable cities and prosperous communities without mineral raw materials.

Highest environmental and social standards

The EU mineral raw materials industry is committed to continuously improving its performance, following the highest environmental and social standards. The European mineral raw materials industry sector is working to improve operations so that land is disrupted as little as possible.

Legally, before any mine or quarry is opened in the EU, the operator must have a plan for restoration of the land impacted by its operations. Many such plans include offsetting or even more-than-compensating any residual losses of biodiversity. Rehabilitation strategies are centered on transforming the area back to its original state or into completely new opportunities. The innovative uses of old mines and quarries across Europe occur in amazing variety and with a vast range of purposes. Many sites deliver multiple functions in their new designs, delivering on new business models for land circularity and multi-functionality (e.g. Eden Project in Cornwall, UK; artificial lakes with floating solar panels that generate green energy (multiple projects across EU)).

Primary production of mineral raw materials is a temporary use of land and only uses 0.5% of the EU land area. Yet the sectors' benefits are far reaching for society. Apart from legacies of history, every European country has stories of post-closure biodiversity regeneration that include eco-tourism, recreational facilities, and a variety of small business enterprises.

Safe and healthy working conditions are a top priority of the European raw material supply industries. Companies also frequently extend workforce health and wellbeing programmes to local communities and contractors, ensuring positive effects on people in the surrounding areas. Mineral raw materials have always contributed decisively to human evolution and wellbeing and will continue to do so in the future.

Action 3 – Launch research and innovation on waste processing, advanced materials and substitution of critical raw materials

Launch critical raw materials research and innovation in 2021 on waste processing, advanced materials, and substitution, using Horizon Europe, the European Regional Development Fund, and national R&I Programmes

Leading innovation

European companies are global leaders in innovation and the suppliers of raw materials used for infrastructure development and a wide range of downstream industries. The sector is constantly developing stronger, more durable, and more efficient materials/procedures/machineries for these purposes. European innovation and high-tech development also contribute to significant positive impacts both in the EU and globally.

To achieve a truly circular economy, all the different phases of material cycle and product cycle must undergo radical transformations to maintain the value of products and materials in the economy for as long as possible. However, when addressing secondary raw materials, waste streams and waste processing, several complex issues seem to be overlooked or not sufficiently addressed.

The issues associated with the availability of secondary raw materials, identification of waste streams and availability of collection and recycling technologies should be adequately addressed. In many cases, the needed technologies and know how have not been developed or are at initial stage (or they are not economic feasible) and consequently will not be able to be implemented at scale level in the near future.

The EU should work to identify the right balance between dedicating resources to achieving technologies on waste processing and advanced materials able to be implemented at scale in the next years and developing those technologies requiring more time and resources but currently unavailable in the EU.

The current regulatory landscape features the rise of a high number of EU initiatives addressing the entire life cycle of products, from design and manufacturing to consumption, repair, reuse and recycling. These initiatives are being developed in the frame of the EU Green Deal and Circular Economy Action Plan to reduce EU's carbon emissions and increase the EU's circular material use rate while boosting economic growth.

However, scientific research and studies have undeniably confirmed that the sole secondary raw materials pathway is insufficient to satisfy the demand for strategic raw materials coming from industry in the EU. Consequently, a careful balance between primary and secondary raw materials must be achieved, with adequate resources, technologies, innovation and regulatory framework able to support both routes.

With regards to substitution, all the materials featured on the EU CRM list as well as many other raw materials are produced outside the EU and imported by EU industry. This inevitably translates in high purchase prices of raw materials and consequent costs for EU companies. Considering this, many EU companies have, over time, developed substituting strategies to replace costly raw materials with cheaper materials, in some cases at the cost of efficiency. Consequently, EU companies are currently maintaining expensive raw materials in their value chains only when absolutely necessary for the well-functioning and efficiency of their products.

The substitution of materials should therefore be left to the natural forces of the market and not be regulatory induced to avoid unwarranted negative consequences impacting workers, products' efficiency, and end-users.

Action 4 – Map the potential supply of secondary critical raw materials in Europe and identify viable recovery projects

Map the potential supply of secondary critical raw materials from EU stocks and wastes and identify viable recovery projects by 2022.

Circular Economy as one of the top priorities

The European mineral raw materials industry has made the Circular Economy one of its top priorities, working to reduce and reuse waste, transforming waste into resources, improving both the efficiency of raw materials usage and the recyclability of products made from primary minerals and metals. Eco-efficient processes and products will also continue to be a fundamental driver for the sector, improving energy, water and material efficiency.

However, the sole mapping of the potential supply of CRMs from EU stocks and waste (including mining waste) is insufficient without a careful evaluation of the collection, recovery and recycling infrastructures. Indeed, while the mapping of EU stocks and waste is an important step to identifying secondary CRM routes and consequently reducing the use of virgin materials, it will not translate in the expected benefits if the necessary collection, recovery and recycling infrastructures - and associated technologies, skills and knowhow - do not exist or are not sufficiently encouraged and implemented at EU level.

Action 5 – Identify priority mining and processing projects for critical raw materials in the EU

Identify mining and processing projects and investment needs and related financing opportunities for critical raw materials in the EU that can be operational by 2025, with priority for coal-mining regions.

Policymakers are currently working on creating the necessary regulatory framework, market and social environment to boost secondary raw materials and related products; however, this should be combined with encouraging primary production of CRMs in the EU where they occur, independently of their location in a coal-mining region.

In particular, the EU and its Member States should increase cooperation in the field of EU CRM production and commit to dedicating more resources and efforts to streamlining licensing and permitting processes at Member State level, supporting the EU mining industry and favouring a radical shift from entrenched anti-mining social sentiments to pro-mining social support through public awareness activities and sharing of best practices in the field of EU sustainable mining.

Action 6 – Develop expertise and skills in mining, extraction and processing in regions in transition

Develop expertise and skills in mining, extraction and processing technologies, as part of a balanced transition strategy in regions in transition from 2022 onwards.

EU industry and companies are best fit to identify the specific needs of their value chains and their workers in terms of expertise and skills and therefore should be considered the natural partners in the Member States and regions.

- "Innovation" Fitness-check of (European and national) patent and standardisation procedure
- Patent procedures: Assessment of the true relevant statistics for the raw materials sector is and bureaucratic hindrances need to be removed.
- Trademark registrations: The raw materials industry will be touched by two categories of trademarks: the one for machinery and the one for mineral products. Both should be considered when assessing the innovation rate in the sector.
- Standardisation: The choice of convenors and technical working group members of the CEN and CENELEC TCs needs to be submitted to tighter scrutiny and the assessment of the innovation potential or hindrances should be assessed when issuing the mandate for a working group.
- Capacity building: Work started under the European Skills, Competences, Qualifications and Occupations (ESCO) with the identification of professional profiles needs to be continued with the EU-wide standardisation of qualifications. The raw materials industry was not involved in the development of EU's Skills Blue Prints exercise. Considering the Innovation agenda of the sector such a targeted exercise could be desirable.
- The minerals sector will require a specific Mining Competence Centre and other professional organisations to provide active training and coaching for professionals of SMEs on the ground and on site, to facilitate transfer of knowledge.
- Support national training courses for project applications and project management, and not leave this field entirely to established companies but provide new forms of "train the trainers" in the respective countries.
- Supporting the "genius": Special awards for innovations in the raw materials sector and for the raw materials related courses should be created.
- Extending awareness raising, education, skills and capacity building: the EIT Raw Materials.

Further education and life-long-learning, in particular with regard to health and safety, automation and robotics, as well as digitisation, should be fostered through a European-wide multi-lingual training programme. Such training material and courses can also be exported as a service.

Action 7 – Deploy Earth-observation programs and remote sensing

Deploy Earth-observation programmes and remote sensing for resource exploration, operations and post-closure environmental management.

Geoinformation and Earth Observation can support the increasing sustainability of the mineral raw materials industry.

Increasingly digitized and new EO-based products/services will provide new tools for better and more accurate mineral mapping/ exploration, environmental and mine production monitoring, mine security and smarter operation planning significantly improving overall efficiency and reducing costs.

Early warning systems, together with the other EO data-based services (e.g., Copernicus data, DIAS, TEPs), will lead to a reduction in the environmental impacts of mineral extraction and processing as well as help minimize the risks for the local population and nature.

Action 8 – Develop research and innovation projects

Develop Horizon Europe R&I projects on processes for exploitation and processing of critical raw materials to reduce environmental impacts starting in 2021.

Relevant contributors: EIT Raw Materials, R&I community. Remarks, sustainable subsurface management integrating geo-resources (energy, water, raw materials) and environmental conditions (natural hazards, anthropogenic impacts) across all relevant clusters

Energy:

- Geothermal assessment and inventory
- Energy Storage
- Carbon Capture, Utilization and Storage

Mineral Resources

- Minerals: inventory /assessment /classification
- Exploration / undiscovered deposits
- Recycling and re-use potential of mineral based secondary resources

Water Resources - Climate change and the water – food – energy nexus

- Groundwater and the biosphere, biodiversity and ecosystem services

- Data and tools to support EU and UN policy development and implementation
- Chemical status of European groundwater

Earth Observation

- Climate related geohazards
- Earth Observation for Raw Materials

Geochemistry: Soil chemical status in EU (soils quality assessment, risk assessment)

Marine Geology

- Marine network EMODNET
- Marine Georesources (minerals)

Sustainable RM processing

- Technologies enabling resource efficient processing; highest possible yield and per raw material usage alongside development in use and valorisation of processing side material streams and by-products flows.
- Smart technologies enabling seamless data communication and exchange along the value chain from exploration down to the production of more complex, durable, miniaturized & raw material efficient products, fit for a circular economy.
- Integration of processes for industrial symbiosis.
- Innovative primary & secondary conversion and processing technologies enhancing and continuously determining RM quality and performance.

Advanced material engineering for new market opportunities:

- Development of more complex, higher functional density and increased reliable applications.
- Multi-materials (layered or alloys), i.e. integrated and combined micro/nano use of many RMs or new or existing market applications while at the same time designing for up- and re-manufacturing, reuse and recycling.
- Enabling technologies and addressing raw materials qualities and quantities, e.g. critical RMs, through new processes, other RMs or combination of RMs to provide the same, similar or even better performance.

Contribution to circular economy

- Managing material and product loops; re-use of processing side streams and by-products and maximising end-of-life (EoL) product recycling back to RMs or products
- Life Cycle Assessment (LCA), standards, traceability and environmental performance can be measured easier and with better accuracy.

- Materials identification or traceability techniques
  a) Continuous and highly accurate (raw) materials identification or traceability techniques for precision raw material sorting.
  b) Secondary raw material flows into the production cycle will require new separation technologies and new business models support to entrepreneurial efforts.
  c) Agile sorting, recycling, refining, dismantling and reuse

Development and implementations of logistics and/or development of and transition into new business models

- Using a functionality and returning material or product after use, and/or
- Sharing the use of a product.

Processing for the recovery of valuable elements also from complex & low grade feed stocks and technologies for residual matrix valorisation, while providing safe sinks for toxic remnants or reuse in other industries.

Action 9 – Develop strategic international partnerships & Action 10 – Promote responsible mining practices for critical raw materials

Develop strategic international partnerships and associated funding to secure a diversified and sustainable supply of critical raw materials, including through undistorted trade and investment conditions, starting with pilot partnerships with Canada, Latin-America and other interested countries in Africa and the EU's neighbourhood in 2021.

Promote responsible mining practices for critical raw materials through the EU regulatory framework (proposals in 2020-2021) and relevant international cooperation.

To guarantee sustainable and resilient EU value chains, the supply of raw materials from third countries must deliver in line with the EU's Green Deal objectives. EU's partners should therefore be committed to similar objectives in terms of sustainability and mitigation of climate change to not jeopardise the EU's efforts in the sector and guarantee global level playing field.

The industry would therefore support the development of a Sustainable Products regime that would not only cover "products" but also "substances" as defined in other EU legislation.

Strategic partnerships cannot be developed without a common understanding of such sustainability criteria.

The Development of the "Sustainable Raw materials Principles is a move in the right direction, however, deserves far more detailed work and needs to be coordinate with the development of the Sustainable Finance criteria.

Alongside internationally set prices, Europe has a significant import dependency for all metal ores and concentrates, including 100% import reliance for several specialty metals and rare earths. Europe also imports far more primary metal than it exports. There is strong evidence for major state-aid interventions and support in metals production outside of the EU, in China. As an example, a recent OECD report concluded that 85% of subsidies in the aluminium sector went to 5 Chinese companies. Such actions have resulted in excess capacities in China, at the same time as European production has stalled.

For example, the European mining of other non-ferrous metal ores sector is trade intensive and faces strong competition from global producers in the domestic EU market. Imports represent on average 89% of domestic demand in value and 101% in volume over the period 2014-2016.

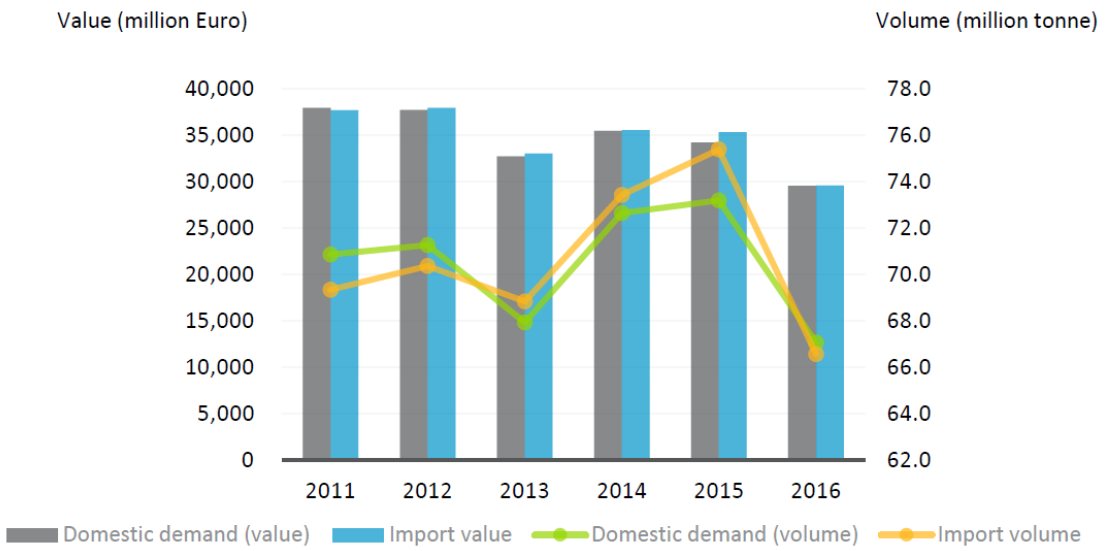


Figure 1: Domestic demand of NACE 07.29 n the EEA in Euro and tonne from Eurostat

European mining of iron ore is also trade intensive and faces strong competition from global mining companies mainly from Brazil. Outside of Brazil, major producers and competitors include Canada, Russia, and South Africa. Imports represent on average 100% of domestic demand in value and 97% in volume over the period 2014-2016.

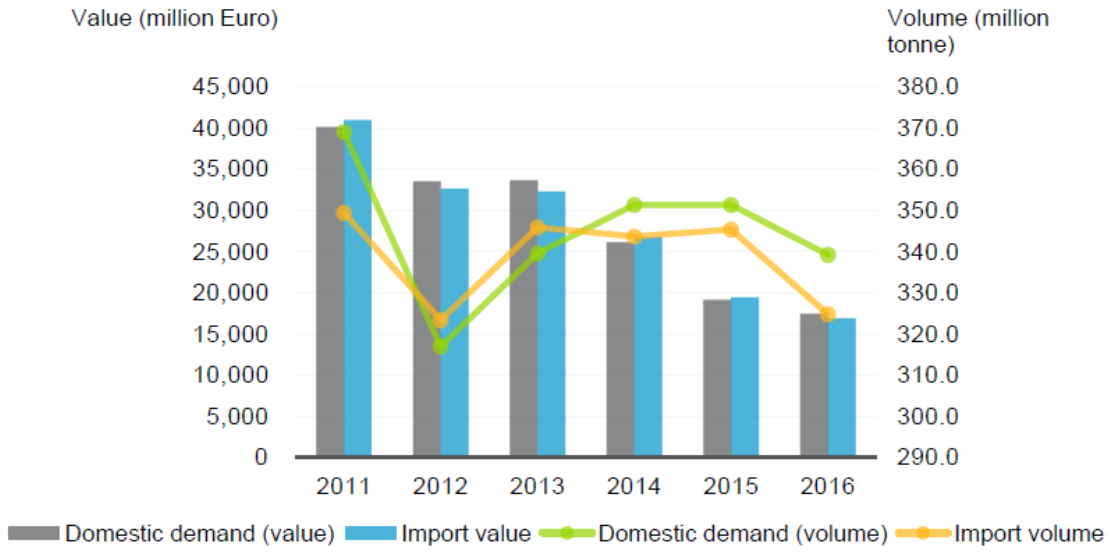


Figure 2: Domestic demand of NACE 07.10 n the EEA in Euro and tonne from Eurostat

The European raw materials mining sector is crucial to achieving the 2030 climate target and to making Europe the world's first climate neutral continent

Carbon leakage protection measures should remain the main instrument protecting the competitiveness of the energy intensive industries, and encouraging innovation

Together with its equipment suppliers and downstream customers, the European mining industry is leading the development of energy efficient and low carbon technologies.

Raw materials mining and quarrying activities are essential in terms of mitigating supply risk, e.g., providing materials for the deployment of low-carbon technologies and agriculture, and increasing the resilience of manufacturing value chains. The European minerals sector can secure availability of essential materials needed for current and future technologies to create a climate neutral, service and welfare orientated, circular and resource efficient economy while sourcing raw materials in a sustainable and responsible way. Mining and quarrying can encompass sustainable activities based on their own performance and/or enabling activities: minimising their impacts makes a significant contribution to climate change mitigation and adaptation.

Additionally, mining in Europe is operating at highest environmental and social standards compared to non-EU countries. The industry in Europe is committed to substantially contribute to climate change mitigation: it not only continuously explores methods of decarbonisation in order to efficiently and effectively fulfil the continued increasing demand for resources, but also enables other economic activities to improve their environmental performance.

At the same time, the mineral raw materials industry is highly electro-intensive, exposed to a significant risk of direct and indirect carbon leakage. Unable to pass through costs and currently faced with the prospects of investment in the EU area worsening simultaneously with a decrease in domestic demand, the EU raw materials sector is concerned that any lack of an effective carbon leakage protection system as it is now will undermine the international competitiveness of the industry through the further loss of market share and profit margins to competitors who do not face similar costs. In this context, sufficient free allocation according to needs must continue to be provided to the industry. The indirect costs reimbursement also needs be taken into consideration as electrification will be the key to achieving a low-carbon economy.

Eurostat has indicated a decreasing profitability, with an average gross operating rate of 43% in 2012, decreasing to 13% in 2016. Production costs are driven by energy, equipment and labour costs which are all expected to increase during the next 10 years together with the carbon price.

Compared to other regions of the world that are part of the same global market, this would imply a loss of competitiveness for EU mining companies, which may lead to decrease in profit and market share vis-a-vis non-EU producers not facing such additional costs. Consequently, there is a risk of carbon leakage, given that

major competitors in other regions of the world do not have similar cost issues when producing the same products. This problem is likely to be further exacerbated by the rising Carbon price which in turn is likely to result in rising electricity prices. On a long term, an increased electricity price without any possibility of passing it through would mean a re-planning of the mine production based on an increase in the cut-off in the calculation of the ore base. Such a re-planning is an extensive work that cannot be done at the present time, but what would in practice happen is that the life of the mine would also be shortened.

Annex 1: Future demand forecast for raw materials critical for low carbon technologies

Type	2011	2020	2030	Compound Annual Growth Rate (CAGR)
Antimony	198,8	261,58	317	2.49%
Arsenic Trioxide	52	59,4	62,8	1.00%
Barytes	7,800,000	9,112,000	10,331,300	1.49%
Beryllium	300	322	405	1.59%
Bismuth	8,5	11,04	14,23	2.75%
Boron	4,300,000	4,835,600	5,498,500	1.30%
Cadmium	30,7	33,6	37	0.99%
Chromium	9,145,000	12,823,600	16,911,000	3.29%
Cobalt	130,7	227	336,7	5.11%
Copper	19,777,000	23,159,000	27,386,000	1.73%
Gallium	288	450	630	4.21%
Germanium	197	319	433	4.25%
Gold	4,31	5,78	7,14	2.69%
Graphite	925,000	1,178,000	1,311,740	1.86%
Hafnium	85	112	142	2.74%
Indium	1,36	1,9	2,5	3.26%
Lead	9,656,000	12,588,000	15,846,500	2.64%
Lithium (Li Content)	20,8	28,25	36,5	3.01%
Magnesium	1,114,300	1,545,900	2,018,400	3.18%
Manganese	20,895,500	29,720,500	39,295,000	3.38%
Mercury	1,93	2,375	2,875	2.12%
Molybdenum	333,3	483,21	648,34	3.56%
Nickel	2,686,500	3,752,000	5,065,500	3.39%
Niobium	78,75	131,212	180,985	4.48%

Type	2011	2020	2030	Compound Annual Growth Rate (CAGR)
Rhenium	65	89	111	2.81%
Scandium4 Sc Refinery	10	30	50	8.84%
Selenium4 Se Refinery	2,65	3,94	4,97	3.36%
Silver	32,05	36,6	43,075	1.57%
Strontium	380	590,1	641,1	2.79%
Tantalum	988	1,301	1,82	3.27%
Tellurium#1 Te Refinery	742	1,255	1,826	4.86%
Thallium	10	10	10	0.00%
Tin	334,15	415,75	482,6	1.95%
Titanium5 Ti TiO2 Content	6,000,000	6,940,900	7,986,400	1.52%
Tungsten	120	146,6	181,6	2.20%
Vanadium	60	73,8	88,4	2.06%
Zinc	15,500,000	19,353,500	23,758,000	2.27%
Zirconium	1,410,000	1,928,200	2,486,500	3.03%

Source: Joint Research Center, 2016

Annex 2 - Raw materials essential to achieving a low-carbon economy

Raw material	Contribution to low carbon technologies					
	Transport	**Wind**	**Solar**	**Batteries**	**Securing the EU base load**	**Enhancing recycling**
Bauxite and aluminium	• Every kilogram of aluminium replacing steel in car manufacture reduces the overall weight of the vehicle by a further kilogram. • Using 100 kg of aluminium in a car reduces CO2 emissions by up to eight grams per kilometre travelled, saving up to 46 litres of fuel per year. • Each kg of aluminium in today's articulated trucks saves 26 kg of	• Wind turbines can require several tonnes of aluminium in parts such as the gear box. • The composite technology employed in the aluminium honeycomb delivers a core material that combines high strength with low weight, highly desirable in the development of wind turbines, rotor blades and turbine core	• For solar thermal collectors (flat-plate and evacuated tube collectors), aluminium is mainly used in absorbers, casings and frames. Studies support the trend of increased aluminium use in absorbers. Out of 289 systems analysed 34% use aluminium absorbers.[3]	• Aluminium-air batteries have demonstrated the ability to power an electric vehicle for up to 1,000 miles. The Al-air battery consumes aluminium as a fuel. Aluminium's energy density far surpasses conventional battery technologies and can rival gas and diesel fuels.	There are only three bauxite mines (GR) and one alumina plant (IE), one anode plant (NL) and three cathode plants (F, Pl, UK) left in the EU. The mines are in the process of full electrification to eliminate CO2 emissions from fossil fuel. They represent a major electricity consumer in their regions.	Aluminium recycling rates from construction materials are in the order of 80%.

[3] Jan Maurice Bödeker (project management), Marc Bauer, Dr. Martin Pehnt: Aluminium and Renewable Energy Systems – Prospects for the Sustainable Generation of Electricity and Heat, Heidelberg, September 2010.

Raw material	Contribution to low carbon technologies					
	Transport	**Wind**	**Solar**	**Batteries**	**Securing the EU base load**	**Enhancing recycling**
	CO2 throughout their life-cycle.					
Copper	By 2025: • An additional 350 kt of copper will be required to meet energy infrastructure, charging and storage needs • An additional 950 kt of copper will be consumed by the auto sector to meet EV requirements By 2030 • An additional 1 Mt of copper will be required to meet energy infrastructure, charging and storage needs • An additional 3 Mt of copper will be consumed	• The insulated copper cables running down from the generator carry huge currents. A wind turbine contains an estimated 5 tonnes of copper. In a typical wind turbine, copper is used in the power cables, control cables, instrument cables, cooling and heating systems, the generator, transformer, and grounding system. Additionally an average generator weight may equal 8.5 tons and be composed of 35% copper and 65% steel.	• Copper leads up to 8 times more heat that other materials. • Copper is ideal for heat exchangers and especially for solar thermal systems, which are more sustainable than traditional ones. Solar water heaters made of copper can help save up to 34% of energy.		Here are a number of copper mines and smelters across the EU (B, BG, ES, D, P, PL, S, Ro) .The mines are in the process of full electrification to eliminate CO2 emissions from fossil fuel..	Today 50% of EU's copper demand comes from recycled material because the life span of the materials can be decades and the demand is outpacing the return of the material.

Raw material	Contribution to low carbon technologies					
	Transport	**Wind**	**Solar**	**Batteries**	**Securing the EU base load**	**Enhancing recycling**
	by the auto sector to meet EV requirements					
Iron Ore	High-strength structural steel plates and long sections for tower structures, concrete-reinforcing bars for foundations and electrical steels for generators.	Wind turbines are made of 84% iron and steel materials. A single wind turbine can contain as much as several hundred tonnes of steel. A variety of iron-based materials are used throughout a turbine. Electrical steel producing the specific magnetic properties that optimally convert motion to energy, cast iron or forged steel are used for holding the blades in the rotor hub and important structural elements of bearings and rings are made of high-tech steel.	Saw wires used to cut silicon wafers as building blocks for photovoltaic solar cells.		There is only one major iron ore mine and two smaller ones operating in the EU. There are in the process of full electrification to eliminate CO2 emissions from fossil fuel. They represent a major electricity consumer in their regions.	This steel is fully recyclable after a lifespan of about 30-40 years. Steel from construction is recycled at 93% already today.

Raw material	Contribution to low carbon technologies					
	Transport	**Wind**	**Solar**	**Batteries**	**Securing the EU base load**	**Enhancing recycling**
Nickel		In onshore wind power nickel is used mainly in the gearing and generator components. Offshore, given the corrosive marine environment, there are many more opportunities for stainless steels. Copper-nickel alloys can also offer fouling and corrosion protection in the splash zone. Tidal power and emerging wave power systems face similar marine corrosion and fouling environments. Hydroelectric installations use turbines which can use nickel-containing alloys for	Nickel-containing stainless steels may be used for the collector and associated pipes. Concentrating solar power uses arrays of mirrors to concentrate the solar radiation onto receivers, where the temperature can reach 500°C. The heat is transported using molten salts in heat- and corrosion-resistant stainless steel tubing. Stainless steel tanks containing molten salts are also used to store the heat. Photo-voltaic systems generate electricity	Many types of rechargeable battery chemistries exist, each with their own characteristics, such as energy storage capacity for a given weight, operating temperature range and discharge rates. Lithium-ion battery technology has been evolving rapidly and has found widespread application in electric vehicles as well as portable tools and electronic equipment. Two of the most commonly-used batteries, Nickel Cobalt Aluminium (NCA) and	Here is only three nickel ore mine operating in the EU (Fin, GR). There are in the process of full electrification to eliminate CO2 emissions from fossil fuel. They represent a major electricity consumer in their regions.	Enhancing recycling Nickel is amongst the most valuable of the common non-ferrous metals and the world's most highly recycled substance. Nickel and nickel-containing alloys can be returned to their original state or converted to a different, but still valuable, form. Examples are nickel-containing stainless steel scrap being turned into new stainless steel, or nickel from recycled batteries being used

Raw material	Contribution to low carbon technologies					
	Transport	**Wind**	**Solar**	**Batteries**	**Securing the EU base load**	**Enhancing recycling**
		both erosion and corrosion resistance to ensure the longevity of the plant.	directly and may use stainless steel for the panel frames.	Nickel Cobalt Manganese (NCM) use 80% and 33% nickel respectively; newer formulations of NCM are also approaching 80% nickel. Most Li-ion batteries now rely on nickel. Nickel in car batteries is delivering a longer range for vehicles. Nickel is an important part of LED bulbs that are 80-90% more efficient than conventional.		for nickel-containing stainless steel.
Zinc		Off-shore wind farms foundations		Modelling of Zinc Energy Storage System	There are 15 zinc ore mine operating in the EU. There are in the process of full electrification to	Zinc is an inherently recyclable non-ferrous metal and can be recycled indefinitely without any loss of

Raw material	Contribution to low carbon technologies					
	Transport	Wind	Solar	Batteries	Securing the EU base load	Enhancing recycling
				for Integration with Renewable Energy[4] Zinc-air batteries	eliminate CO2 emissions from fossil fuel. They represent a major electricity consumer in their regions.	physical or chemical properties. At present, approximately 70% of zinc comes from primary refining of zinc ores (including 10-15% from recycled sources) and 55% of end-of-life zinc is recycled in Europe covering 30% comes directly from recycled zinc due to rising demand. 60% of all zinc produced worldwide are still in use.

[4] Emad Manla and Adel Nasiri , Power Electronics and Electric Drives Laboratory , University of Wisconsin-Milwaukee / Michael Hughes , ZBB Energy Corporation : Modeling of Zinc Energy Storage System for Integration with Renewable Energy ; www.researchgate.net/publication/261111349

Annex 3 - European Mineral Raw Materials Industry

Mineral Raw Materials in modern society – the lifeblood of the economy

Mineral Raw Materials in modern society are the lifeblood of the economy.

They are the basis for many sectors:

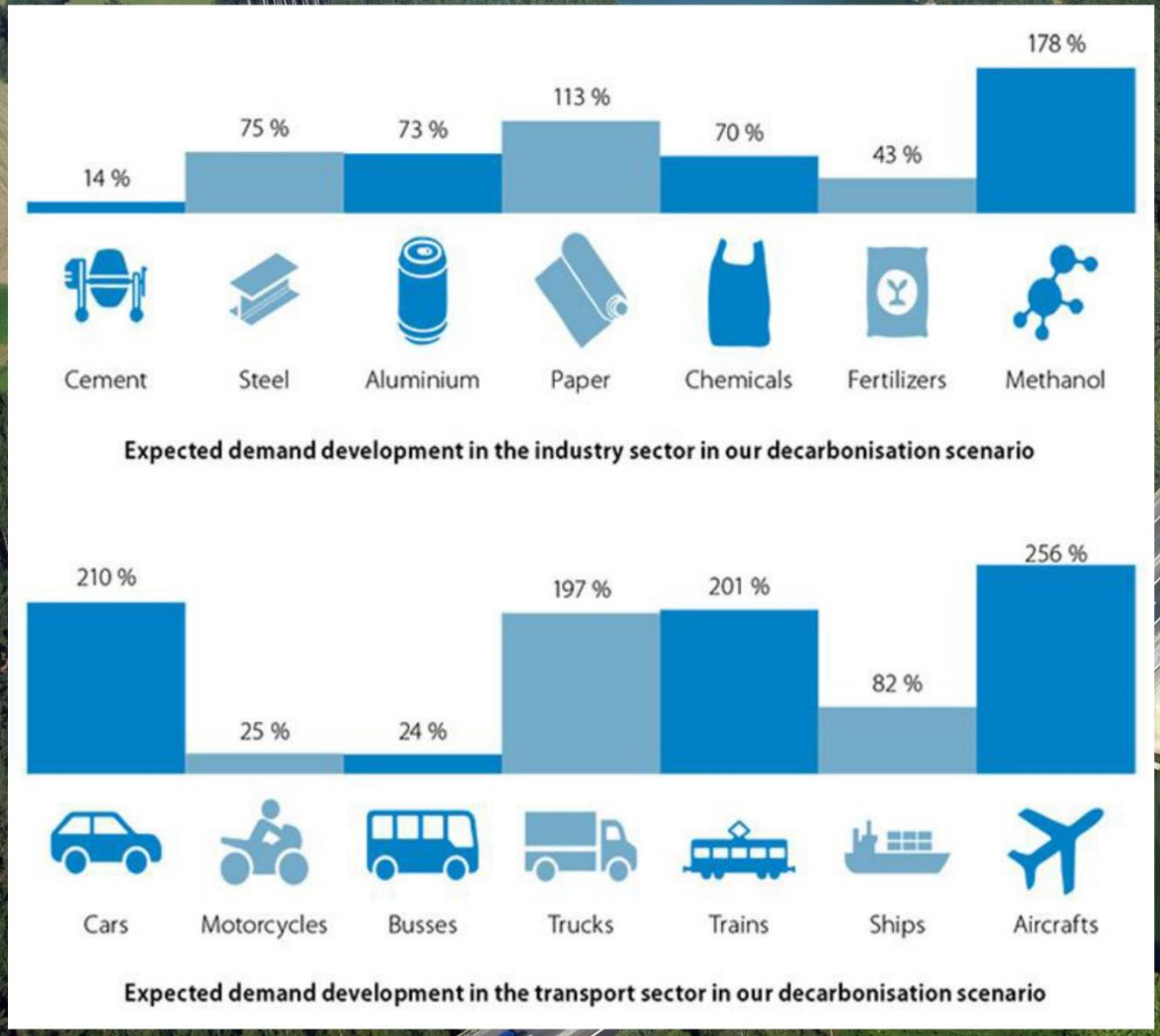
- Agriculture, Construction, IT, Electronics, Energy, Chemistry, Manufacturing, Medicine

- Raw materials depending industries in the EU provided **206 billion EUR of added value**.
- The economic importance of the raw materials sector goes far beyond the sector's own economic activities.
- Whilst engaging about **350.000 jobs within the EU**, there are **more than 24.6 million jobs** in downstream manufacturing industries depend on the secure supply of raw materials.

Data Source: Raw Materials Scoreboard, European Innovation Partnership on Raw Materials, European Union, 2018

Metal and mineral demand: Now and in the Future

With the decarbonisation scenarios developed by ECOFYS, individual materials and sectors are expecting considerable growth rates



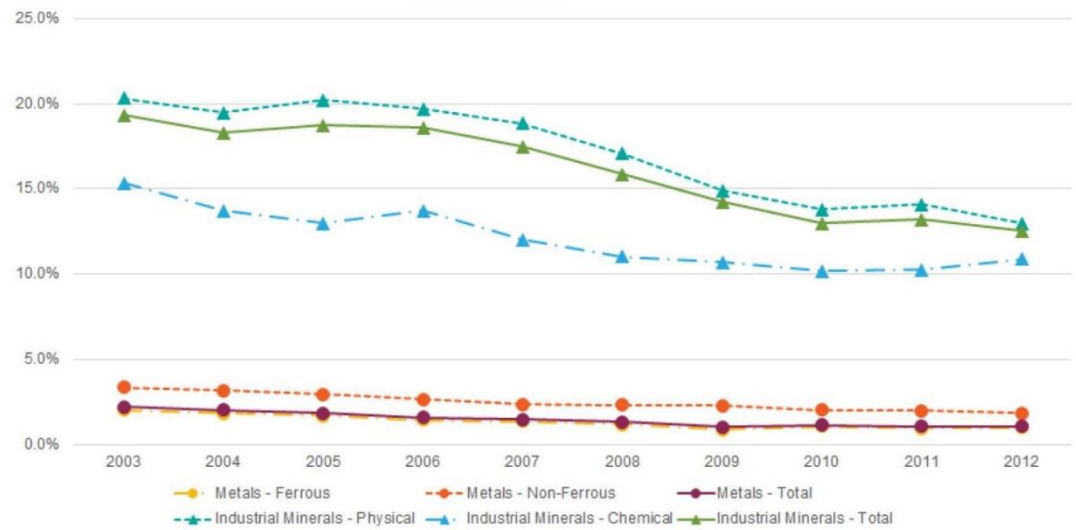
Source: ECOFYS, Energy Transition within 1.5C, A disruptive approach to 100% decarbonisation of the global energy system by 2050 (2018)

European Production

The European Union

- **is self-sufficient in production of sand, gravel and aggregates** (25.000 sites in the EU),
- **is the world's third largest producer of industrial minerals** (about 700 sites in the EU),
- **provides about 40% of EU's metal ores and concentrates** (90 sites in the EU).

EU share of global production



Source: Study on the Competitiveness of the EU Primary and Secondary Mineral Raw Materials Sectors, Final Report for DG Internal Market, Industry, Entrepreneurship and SMEs, 2015

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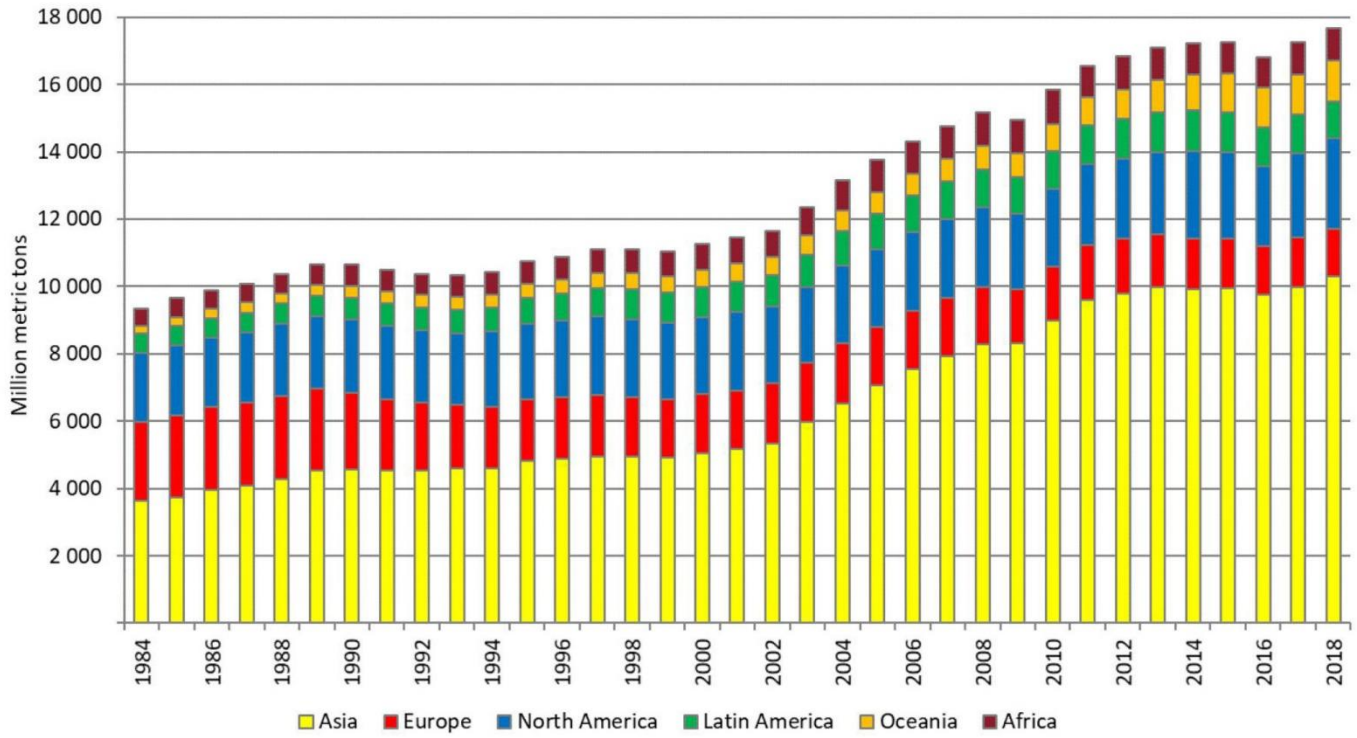
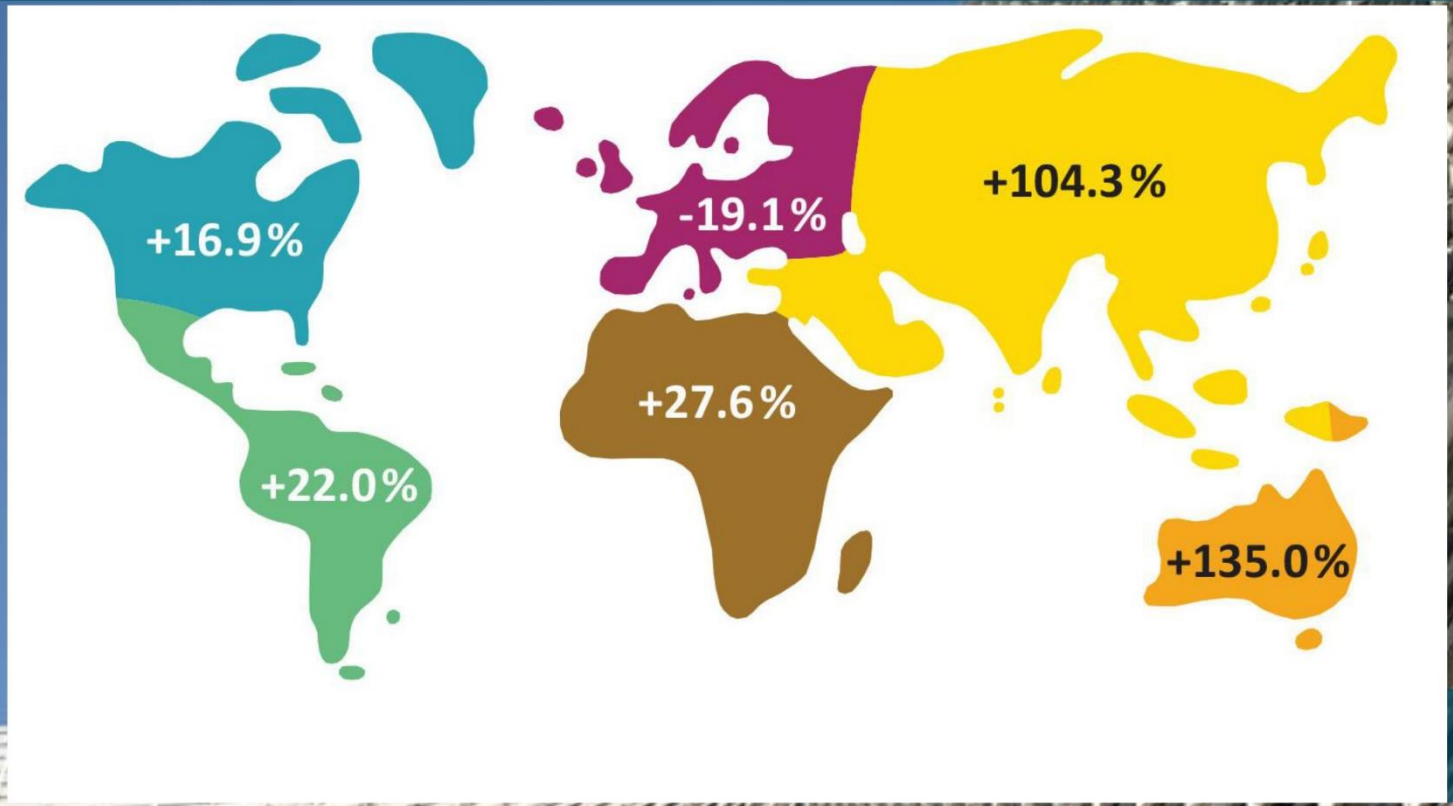
World Mining Production 1984 – 2018
by continents



Without construction minerals, (in Million metr. t)

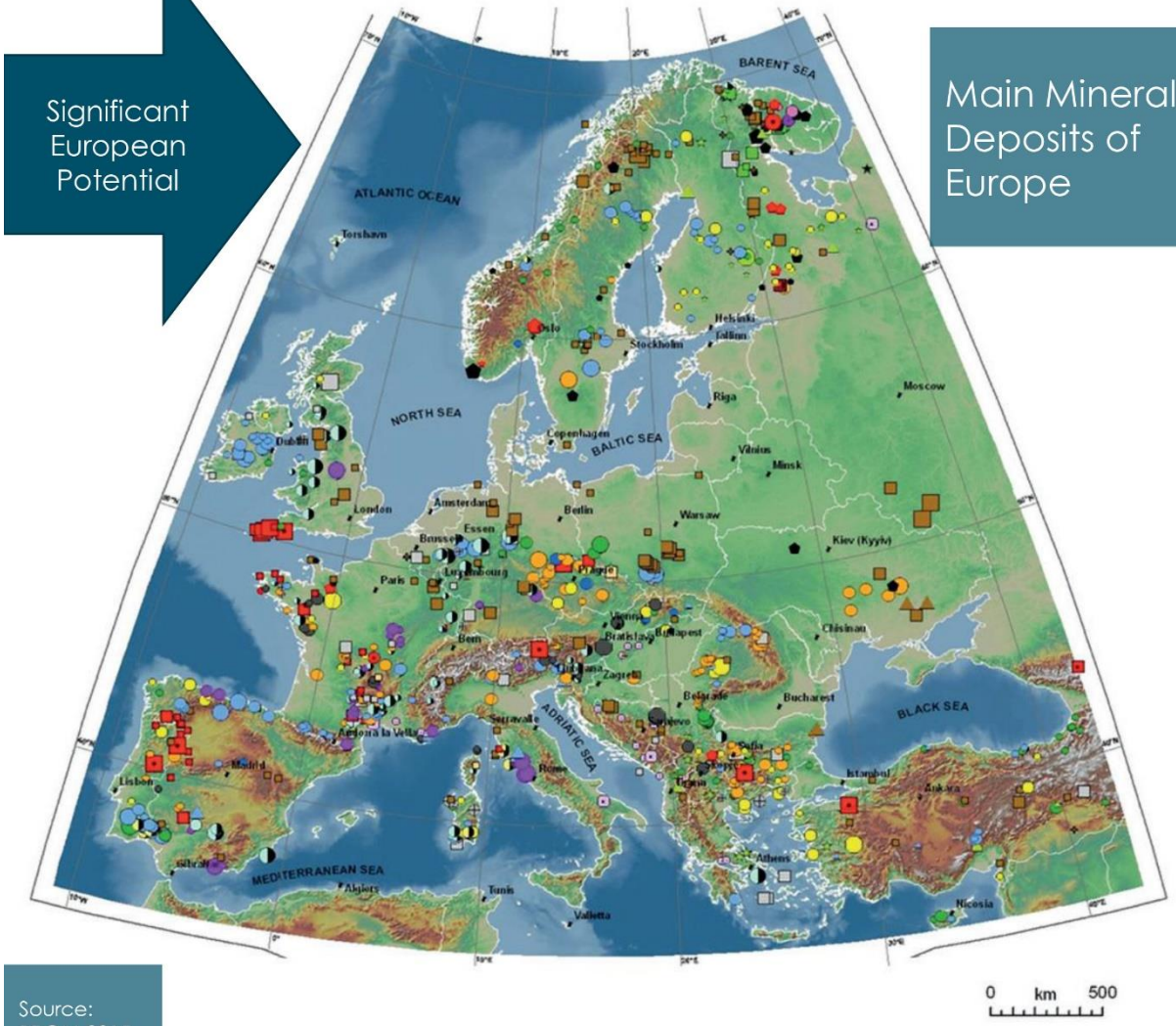
Source:
World Mining Data 2020, Federal Ministry Republic of Austria, Vienna 2020

Declining production rates since 2000 only in Europe – Δ 2000 / 2018



Source:
World Mining Data 2020, Federal Ministry Republic of Austria, Vienna 2020

Significant European Potential



Source: BRGM 2015

Main Mineral Deposits of Europe

Europe has rich mineral resources which can be mined sustainably

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- Europe has its own natural resources, world-class deposits and still major potential. Today, the European mineral raw materials industry occupies no more than a fraction of 1% of the land surface on a temporary basis.
- Mineral exploration is a key factor for developing and maintaining a healthy industry and sustainable access to resources.
- Innovative exploration technologies have allowed to discover more deposits in Europe and to add more reserves to our nations' assets.

Main commodity

- Aluminium
- Antimony
- Arsenic
- Barite
- Bismuth
- Chromium
- Cobalt
- Copper
- Diamond
- Fluorite
- Germanium, Gallium
- Gold
- Iron
- Lithium
- Lead
- Manganese
- Mercury
- Molybdenum
- Nickel
- Phosphate
- PGE Platinum Gr. Elements
- Pyrite
- Silver
- Tantalum
- Tin
- Titanium
- Uranium
- Vanadium
- Tungsten
- Zinc
- Zirconium

Deposit size

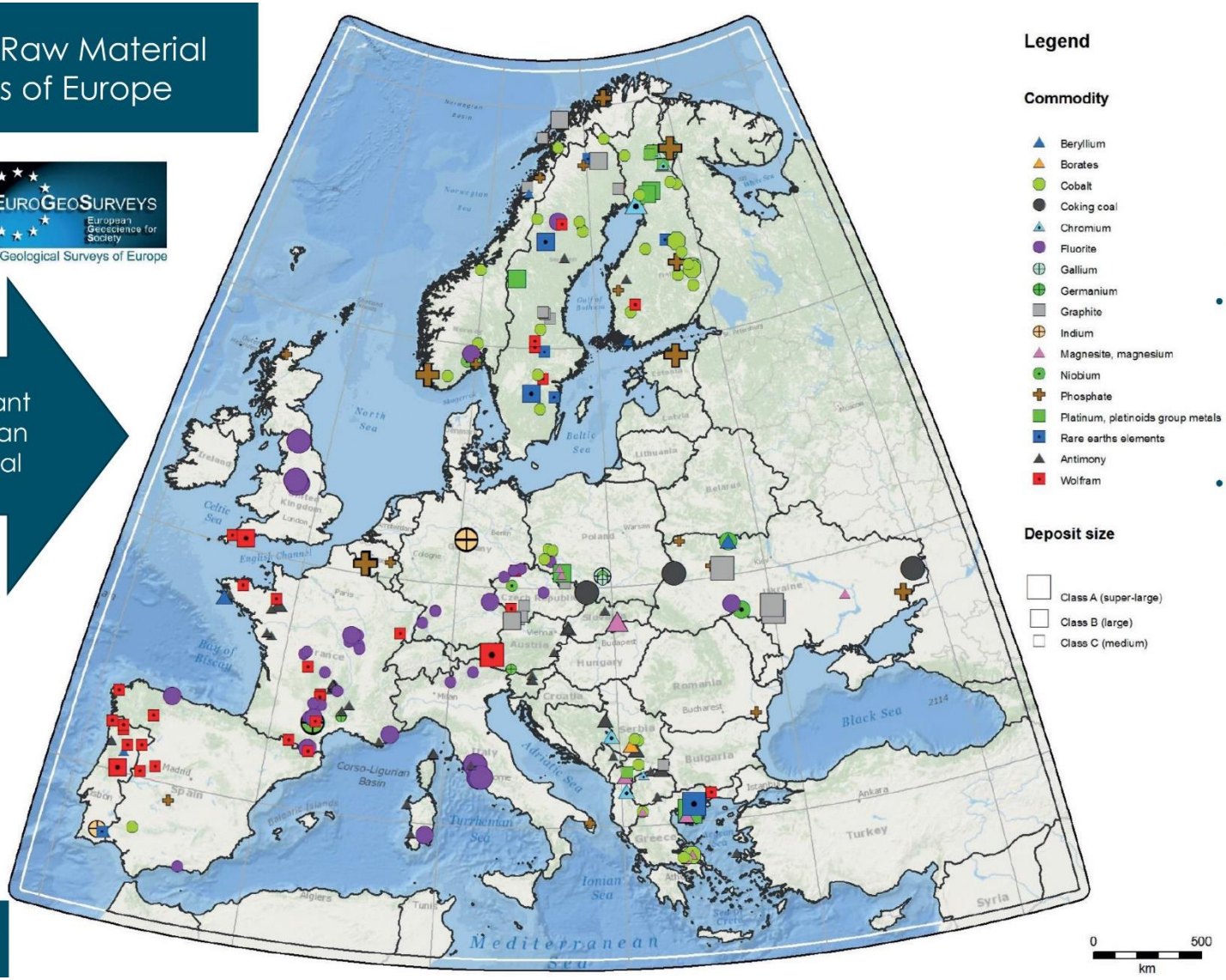
- Class A
- Class B
- Class C

Total deposits : 943

Critical Raw Material Deposits of Europe

EuroGeoSurveys
European Geoscience for Society
The Geological Surveys of Europe

Significant European Potential



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- As global demand for critical raw material grows, primary raw materials will continue to play a key role.
- Mobilising Europe's domestic potential better is an essential part of the EU becoming more resilient and developing open strategic autonomy.

Source: EuroGeoSurveys And BRGM 2015