AGEMERA

Critical Raw Materials for a Resilient Europe

EDUCATIONAL PACKAGE

Importance of Critical Raw Materials

Deliverable 6.3

This project has received funding under the European Union's Horizon Europe research and innovation programme under grant agreement No 101058178.

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Disclaimer

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Executive Summary

Critical Raw Materials (CRMs)

Raw materials have become essential in manufacturing everyday goods and technologies we use every day. Readily accessible raw materials are essential to EU industries and for the continued growth of the European economy. The European economy relies heavily on raw materials, many of which need to be sourced from regions outside the EU. Where the impact of these raw materials on the EU economy becomes significant, they may be deemed critical and referred to as Critical Raw Materials (CRMs).

The European Commission pays close attention to the problem of resources because it must import many raw materials that are of strategic importance for its technological and economic development. The EU has determined that currently, 34 raw materials are critical for Europe.

We are targeting a specific audience with specific educational tools to raise awareness of raw materials. The target groups are university students, high school students, professionals/ experts in the field and public/ policymakers. The main tools to educate these stakeholder groups are AGEMERA courses, micro degree(s) and workshops.

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List of Acronyms

AB	Advisory Board
BuildERS	Building European Communities Resilience and Social Capital project
CRM	Critical Raw Materials
D	Deliverable
DoA	Description of Action
WP	Work Package

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1 Critical Raw Materials of Europe

1.1 Raw Materials and their Importance to Society

The use of natural earth materials has been crucial to the development and advancement of societies through time. Materials derived from the Earth's crust are integral to our daily life and have served many purposes in our development. The most basic of these resources found in the Earth's crust, coal, petroleum and uranium, have been critical to energy security around the globe. Concentrations of minerals within the Earth's crust are important in producing materials necessary for the functioning and future development of society. These may include base metals such as iron, copper, nickel, zinc, tin and lead, which are necessary to common metal alloys and essential to global development.

Precious metals and diamonds are also mined directly from rocks and throughout history, have been important to the expansion of empires and securing trade. Raw materials sourced from the Earth's crust are also widely used in infrastructure and construction (cement, building and roofing material) as well as for stone facades and other polished ornamental features in building construction.

More recently, many of our technologies (mobile phones, computers, automobiles) and sources of renewable green energy (solar and wind) have become more reliant on metals not commonly mined or openly traded on global markets (i.e., rare-earth-elements, indium, tellurium, germanium, gallium). These raw materials are necessary for the development and mass rollout of renewable energy projects to address issues of climate change and the move to a low-carbon economy.

1.2 Critical Raw Materials (CRMs)

Today, raw materials have become essential in the manufacturing of common goods and technologies we use every day. Readily accessible raw materials are critical to EU industries and the continued growth of the European economy. This growth has resulted in an economy that is heavily reliant on raw materials, many of which are not currently sustainable and need to be sourced from regions outside the EU. With future global resource use projected to double by 2030, addressing raw materials from the perspective of primary sources, use, and recycling becomes a priority. Where the impact of these raw materials on the EU economy becomes significant, they may be deemed critical and referred to as Critical Raw Materials (CRMs). CRMs are important for many industrial applications and emerging technologies, which over time have become more complex and make use of more raw materials with each new generation of device. This is true of society in general, which has evolved to make use of more raw materials available in the Earth's crust and make use of them in more complex combinations. An average smartphone typically contains more than 50 raw materials combined in a device with a volume of 40 cm^3 and weighs less than 200 grams. This

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has implications for recycling and how to recover CRMs from technologies to address issues with raw materials supply.

Critical Raw Materials are dependent on two factors:

• impact of any shortage of raw material.

• risk to the supply of a raw material.

The impacts of restricted raw material supply would consist of increases in the cost of various technologies, reductions in manufacturing output and difficulties in the adoption of EU Policies relying on certain technologies.

Supply risk arises primarily from the irregular distribution of some raw material resources around the globe and is determined by geopolitical boundaries. Because of this, resources can be concentrated within individual nations or regions of the globe. This has resulted in a monopoly and possible supply restrictions due to environmental, or regional political factors. Most of the Earth's natural resources are distributed around the globe, such that criticality may not arise. Those that are not equally distributed run the risk of supply stoppages by the country providing them.

1.3 Reasons why a material becomes critical

Supply risk arises primarily from the irregular distribution of some raw materials around the globe and is determined by geopolitical boundaries. Because of this, resources can be concentrated within individual nations or regions of the globe. This can result in a monopoly and possible supply restrictions due to environmental or regional political factors.

The supply of raw materials can be at risk due to a variety of reasons. These can be geological, environmental, economic, or socio-political:

- Deposits are located in one or very few countries.
- Low abundance in Earth's crust.
- Problems in extraction and/or risk for the environment.
- Lack of alternatives in strategic applications.
- Absent or inadequate recycling network.

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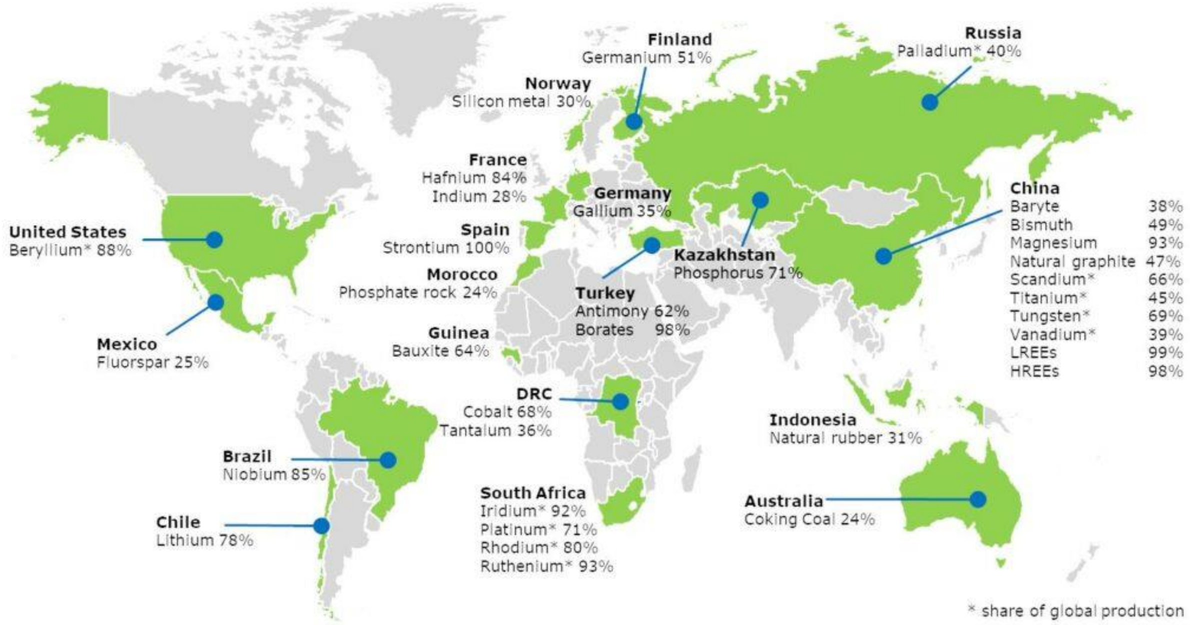

Figure 1. Contribution of countries accounting for the largest share of the supply of primary CRMs to the EU.

(Source: https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX:52020DC0474)

1.4 EU list of Critical Raw Materials

The EU has determined that 34 individual raw materials have been deemed critical for Europe. It is important to note that although these may be CRMs from the perspective of Europe, for their region of origin, these raw materials would not necessarily be considered as critical. The current list of CRMs is not static and can change through time as new resources are discovered or more abundant substitutions are found to replace an element's use in a particular technology or application. There are also elements (e.g., Lithium and Tellurium) that do not currently fall in the critical field for Europe but may become critical as supplies decline or new applications are developed that require more of the raw material. Table 1 shows the EU list of CRMs and their main use, main global supplier, and share.

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Table 1. CRM elements on the EU CRM list

CRM elements on the EU CRM list		
CRM	**Main use**	**Main global supplier and share**
Aluminium	Lightweight structures • High-tech engineering	Australia 28% China 21% Guinea 18%
Antimony	Flame retardants • Defence applications • Lead-acid batteries	China 56% Tajikistan 20% Russia 12%
Arsenic	Semiconductors • Alloys	China 44% Peru 40% Morocco 11%
Baryte	Medical applications • Radiation protection • Chemical applications	China 32% India 25% Morocco 9%
Beryllium	Electronic and Communications Equipment • automotive, aerospace and defence components	United States 67% China 26% Mozambique 4%
Bismuth	Pharmaceuticals • Medical applications • Low-melting point alloys • Solid rocket propellant	China 70% Vietnam 18% Japan 5%
Boron	High-performance glass • Fertilisers • Permanent magnet	Türkiye 48% United States 25% Chile 11%
Cobalt	Batteries • Super alloys • Catalysts • Magnets	Congo, D.R. 63% Russia 7% Canada 4%
Coking coal	Coke for steel • Carbon fibres • Battery electrodes	China 53% Australia 18% Russia 9% United States 6%
Copper	Electronic components • wiring • motors • transformers • plumbing alloys	Chile 28% Peru 12% China 8%
Feldspar	Glass including fibreglass • Ceramics	Türkiye 32% India 20% China 8% Italy 7%
Fluorspar	Steel and iron making • Refrigeration and Air-conditioning • Aluminium making and other metallurgy	China 56% Mexico 21% Mongolia 7%
Gallium	Semiconductors • Photovoltaic cells	China 94% Ukraine 2% Russia 2%
Germanium	Optical fibres and Infrared optics • Satellite solar cells • Polymerisation catalysts	China 83% Russia 5% Belgium 4% Germany 3% Japan 2% United States 2%

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Hafnium	Super alloys • Nuclear control rods Refractory ceramics	France 76% Ukraine 14% China 5% Russia 3%
Helium	Controlled atmospheres • Semiconductors • MRI	United States 56% Qatar 30% Algeria 8%
Lithium	Batteries • Glass and ceramics • Steel and aluminium metallurgy	China 56% Chile 32% Argentina 11%
Magnesium	Lightweight alloys for automotive, electronics, packaging, or construction • Desulphurisation agent in steelmaking	China 91% United States 3%
Manganese	Steelmaking • Batteries	South Africa 29% Australia 16% Gabon 14% China 9%
Natural Graphite	Batteries • Refractories for steelmaking	China 67% Brazil 8% Mozambique 5% India 5% Korea, North 5%
Nickel	Batteries • Steel making • Automotive	China 33% Indonesia 12% Japan 9% Russia 7% Canada 6% Australia 5%
Niobium	High-strength steel and super alloys for transportation and infrastructure • High-tech applications (capacitors, superconducting magnets, etc.)	Brazil 92% Canada 7%
Phosphate Rock	Mineral fertiliser • Phosphorous compounds	China 44% Morocco 14% United States 10% Russia 7%
Phosphorus	Chemical applications • Defence applications	China 79% United States 11% Kazakhstan 6% Vietnam 5%
Scandium	Solid Oxide Fuel Cells • Lightweight alloys	China 67% Russia 17%
Silicon metal	Semiconductors • Photovoltaics • Electronic components • Silicones	China 76% Brazil 7% Norway 6% France 4%
Strontium	Ceramic magnets • Aluminium alloys • Medical applications • Pyrotechnics	Iran 37% Spain 34% China 16%
Tantalum	Capacitors for electronic devices • Super alloys	Congo, D.R. 35% Rwanda 17% Brazil 16% Nigeria 11%

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Titanium metal	Lightweight high-strength alloys, e.g. aeronautics, space and defence • Medical applications	China 25% South Africa 13% Australia 12% Mozambique 10% Canada 8% Ukraine 6%
Tungsten	Alloys, e.g. for aeronautics, space, defence, and electrical technology • Mill, cutting and mining tools	China 86% United States 4% Russia 3% Vietnam 3% Austria 2%
Vanadium	High-strength-low-alloys, e.g. aeronautics, space, nuclear reactors • Chemical catalysts	China 62% Russia 20% South Africa 11% Brazil 8%
Platinum Group Metals (PGMs)	Chemical and automotive catalysts • Fuel Cells • Electronic applications	South Africa 94% - iridium, platinum, rhodium, ruthenium Russia - palladium 40%
Heavy Rare Earth Elements (HREEs)	Permanent Magnets for electric motors and electricity generators • Lighting Phosphors	China 100%
Light Rare Earth Elements (LREEs)	Catalysts • Batteries • Glass and ceramics	China 85% Malaysia 11%

1.5 CRMs found in the EU

The EU still produces many CRMs in many member states. The EU extracts 34% of the global supply of strontium in Spain; 14% of feldspar in Italy, Spain, France, Czechia, Germany, and others; 3% of tungsten in Austria, Portugal and Spain.

The EU processes and refines 49% of the global supply of hafnium in France; 18% of antimony in Belgium, France, Spain and many others; 17% of cobalt in Finland, Belgium and France; 7% of germanium in Germany and Belgium; 5% of silicon metal in France, Spain and Slovakia; 4% of nickel in Finland, Greece and France.

The other materials are produced in smaller shares, usually under 2% of global supply. (“European Commission, Study on the Critical Raw Materials for the EU 2023-Final Report”, p. 27)

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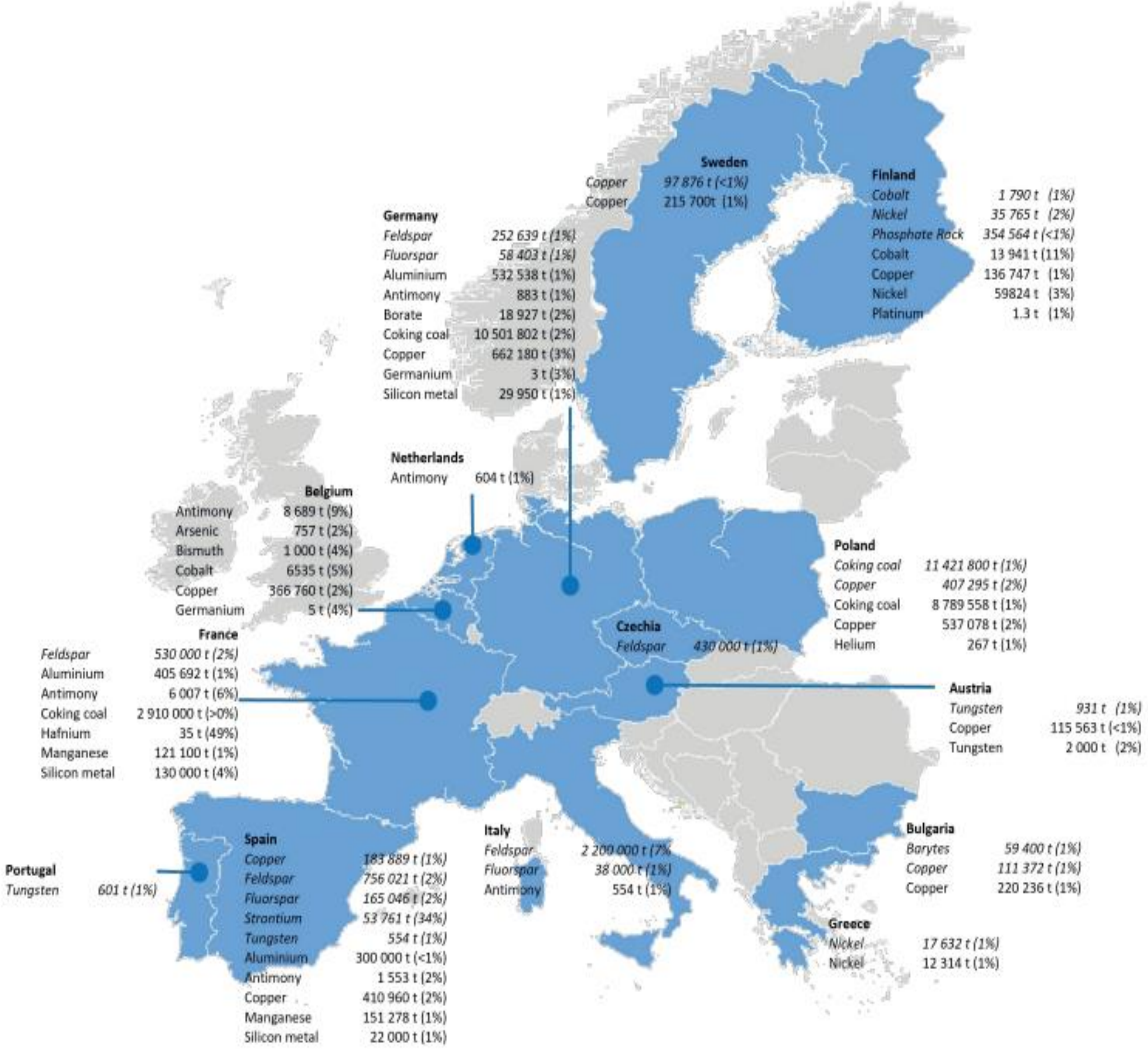

Figure 2. CRMs in Europe

("European Commission, Study on the Critical Raw Materials for the EU 2023-Final Report")

1.6 Importance of CRMs in today's digital and clean transition

The growth of the world's population and the continuous development of society rely more and more on the availability of critical raw materials. Critical raw materials are indispensable for the development and implementation of environmentally friendly and modern technologies.

One of the major critical factors in the demand for commodities is the so-called battery revolution, which stems from the goal of decreasing greenhouse gas emissions and increasing the use of energy sources. Metals such as cobalt and vanadium are essential for the new generation of batteries.

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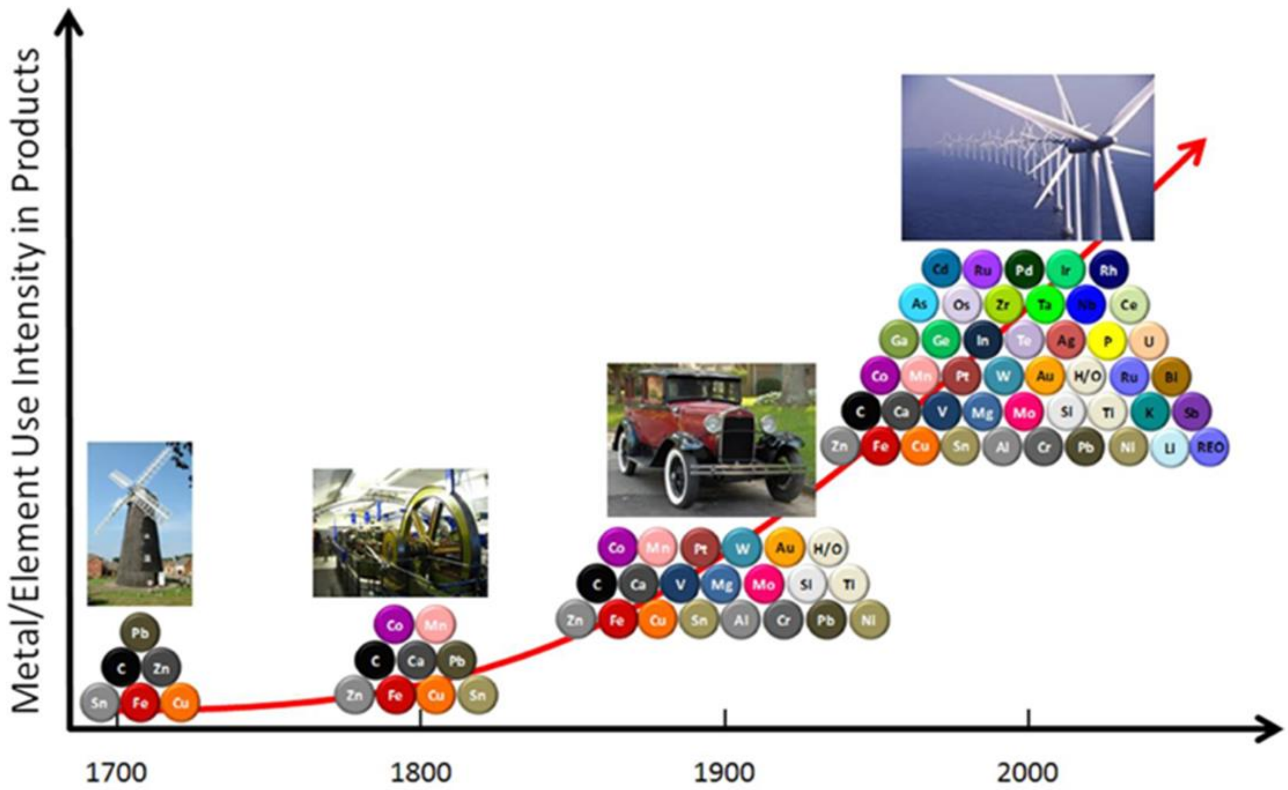

Figure 3. The need for elements found within the Earth's crust, as technology advances

(Markus A. Reuter, Ilkka V. Kojo, Outotec Oyj, Materia2/2012)

1.7 Existence of a CRM potential in EU countries

Table 2. The existence of a CRM potential in EU countries

Country	Current mine production	Known unexploited resources (tonnage data exists)	Assumed unexploited resources only (no tonnage data)
Austria	Mg, W	Sb, In, Mg, Graphite, P, W	Baryte, Bi, Co, Fluorspar, Ga, Ge, Nb-Ta, Sc, Si, REE
Belgium		Baryte, P	REE
Bulgaria		Sb, Baryte, In, Mg, Nb-Ta, PGM	Bi, Fluorspar, Si, W, V
Croatia			Baryte, P
Cyprus			Co, PGM
Czech Republic		W, REE	Sb, Fluorspar, In, Nb-Ta
Denmark/Greenland		Sb, Co, Fluorspar, Ga, Graphite, Nb, Ta, Hf, REE, PGM, V	Be, Ge, P, W
Estonia		P	V, REE
Finland	Co, Mg, P, PGM	Sb, Be, Co, Nb-Ta, P, Sc, W, V, PGM, REE, Hf	Baryte, Bi, Mg, Graphite, Si,
France		Sb, Baryte, Be, Fluorspar, Ge, Mg, Nb-Ta, P, W, REE, Hf	Bi, Co, Graphite
Germany	Baryte, Fluorspar, In(?)	Baryte, Fluorspar, In, Si	Sb, Be, Bi, Co, P, W, PGM, REE
Greece	Co(?), Mg, PGM(?)	Sb, Co, In, Graphite, P, Sc, W, PGM, REE	Bi, Mg, Si
Greenland		Fluorspar, Ga, Graphite, Nb-Ta, W, V, PGM, REE	Sb, Be, Co, Ge, P
Hungary			Sb, Fluorspar, In, Sc, REE
Ireland		In, Mg, P	Baryte, Fluorspar, W, PGM, REE
Italy		Sb, Baryte, Fluorspar, P	Mg, Graphite, Si, W, REE
Latvia			
Lithuania			
Luxembourg			Sb
Malta			P
Netherlands	Mg		Mg
Norway	Graphite	Be, Co, Nb-Ta, P, Sc, Si, V, PGM, REE, Hf	Bi, Fluorspar, Graphite
Poland	Co(?), He, PGM(?)	Baryte, Co, Fluorspar, Ga, Ge, Mg, Si, V	He, Mg, P, PGM, REE
Portugal	In(?), W	Sb, Be, In, Nb-Ta, W, REE	Si, PGM
Romania		P	Sb, Baryte, Bi, B, Co, Graphite, REE
Slovakia	Mg	Sb, Mg	Co, REE, Nb, Ta
Slovenia			Sb
Spain	Fluorspar, Mg, W, PGM(?)	Baryte, Co, Fluorspar, Mg, Nb-Ta, P, W	Sb, PGM, REE
Sweden		Sb, Co, Fluorspar, Graphite, Nb-Ta, P, Si, W, V, REE, Hf	Be, Bi, Sc, W, PGM
United Kingdom	Baryte, Fluorspar, W	Baryte, Fluorspar, P, W, Hf	PGM, REE

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SCRREEN D3.1: Identification and quantification of primary CRM resources in Europe Rev 1.0|

(SCRREEN-D3.1-Identification-and-quantification-of-primary-CRM-resources-in-Europe.pdf)

This project has received funding under the European Union's Horizon Europe research and innovation programme under grant agreement No 101058178.

1.8 Availability of sustainable mining approaches to exploit this potential

The European Union has proposed a strategy for critical raw materials that includes the safe, efficient, and sustainable recovery and processing of all economically and technically recoverable CRMs. With the European Raw Materials Act, the EU aims to ensure a secure and sustainable supply of critical raw materials for Europe's industry and significantly lower the EU's dependency on imports from single-country suppliers.

Key pillars of the Act

- Setting clear priorities for action
- Building European capacities
- Improving resilience
- Investing in research, innovation and skills
- Promoting a more sustainable and circular critical raw materials economy

There are several sustainable mining initiatives that have been proposed to extract CRMs in an environmentally friendly manner[1]. The report emphasises the need for governments and companies to recognise the social impacts of mining and enact laws and regulations that require community consultation throughout the life of a mine. The Alliance for Responsible Mining has developed a Sustainable Mines Program to promote sustainability as a progressive path towards a responsible, productive, and ethical sourcing solution to the industry[2]. McKinsey has published an article on creating the zero-carbon mine, which outlines solutions to decarbonise the majority of emissions[3].

1 How to Advance Sustainable Mining | International Institute for Sustainable Development (iisd.org)
2 Sustainable Mines Program (responsiblemines.org)
3 Creating the zero-carbon mine | McKinsey

1.9 Automation

Automation is expected to play a significant role in improving production processes and energy efficiency in the mining industry. The mining industry in Europe has been gradually adopting automation to improve safety and efficiency standards.

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- **Automation in Mining**: technology alone cannot give an edge to mining organisations, but technology applied with logistics and strategy can make a significant difference.
- **Automation Technology**: the current state of automation in various stages of the mining life cycle, such as exploration, mineral processing, drilling, and transportation.
- **System Engineering and Management**: the need for system engineering and management processes to support the design, implementation, and operation of automation in mining.
- **Human Factors Engineering**: the role of human factors engineering in understanding the impact of automation on human operators, tasks, and socio-technical systems.

Sustainable Intelligent Mining Systems - European Commission (europa.eu)
Automation in the Mining Industry: Review of Technology, Systems, Human Factors, and Political Risk | Mining, Metallurgy & Exploration (springer.com)

1.10 Digitalisation

The mining industry in Europe has been gradually adopting digitalisation to improve safety and efficiency standards [2, 3]. The European Union has also been promoting the use of digital technologies in the mining sector to reduce environmental impact and improve sustainability [3]. The MASTERMINE project is one such initiative that aims to promote autonomous operations and ensure safety and stability in critical structures [2].

(1) European Mining in the Green and Digital Era - CORDIS. https://cordis.europa.eu/project/id/101091895.
(2) Digital Mining in Europe: New solutions for the sustainable production .... https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/digital-mining-europe-new-solutions-sustainable-production-raw-materials-own-initiative-opinion.
(3) 2024 Digitalisation in Mining Europe Conference. https://mininginnovationnetwork.swoogo.com/DME2024.

1.11 Artificial Intelligence

Artificial Intelligence (AI) is expected to play a significant role in the European mining sector [1 2 3]. AI can help mining companies optimise their operations, reduce costs, and improve safety standards [1 2 3]. For example, AI can be used to analyse geological data to identify mineral deposits, monitor equipment performance, and predict maintenance needs [3]. AI can also help mining companies reduce their environmental impact by optimising energy consumption and reducing waste [1 3]. However, the adoption of AI in the mining industry is still in its early stages, and there are challenges to overcome, such as data quality, data privacy, and cybersecurity [1 2 3].

(1) The Use of AI in the Mining Industry Insights and Ethical Considerations. https://www.ieai.sot.tum.de/wp-content/uploads/2022/12/Dec-2022_-AI-and-Mining-Research-Brief_FINAL.pdf.
(2) The AI Revolution in Mining: Opportunities and Risks. https://theoregongroup.com/energy-transition/technology/the-artificial-intelligence-revolution-in-mining-opportunities-and-risks/.
(3) Top 10 uses of artificial intelligence in mining. https://miningdigital.com/articles/top-10-uses-of-artificial-intelligence-in-mining.

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1.12 Sustainable Development Goals

The Sustainable Development Goals (SDGs) are a set of 17 global goals adopted by the United Nations General Assembly in 2015 to be achieved by 2030 [1]. The mining industry in Europe has been gradually adopting digitalisation and automation to improve safety and efficiency standards [2] [3]. The European Union has also been promoting the use of digital technologies in the mining sector to reduce environmental impact and improve sustainability [3]. The SDGs can serve as a framework for mining companies to align their operations with sustainable development principles [1]. For example, SDG 7 aims to ensure access to affordable, reliable, sustainable, and modern energy for all, which can be achieved by adopting renewable energy sources in mining operations [1]. SDG 12 aims to ensure sustainable consumption and production patterns, which can be achieved by reducing waste and improving resource efficiency in mining operations [1]. SDG 13 aims to take urgent action to combat climate change and its impacts, which can be achieved by reducing greenhouse gas emissions and adopting low-carbon technologies in mining operations [1].

In summary, the SDGs can have a positive impact on the European mining sector by providing a framework for sustainable development and encouraging the adoption of digital technologies and automation to improve safety, efficiency, and environmental performance.

(1) Impact of minerals policy on sustainable development of mining sector .... https://link.springer.com/article/10.1007/s13563-021-00248-5.
(2) Drivers of sustainability practices and contributions to ... - Springer. https://link.springer.com/article/10.1007/s43621-021-00025-y.
(3) Europe’s green dilemma: Mining key minerals without ... - POLITICO. https://www.politico.eu/article/europes-green-dilemma-mining-key-minerals-without-destroying-nature/.

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2 Educational package tools

The Educational package is the list of educational tools that we use to deliver an understanding of the importance of raw materials and their exploration, mining and processing.

The target groups are:

- University students
- Highschool students
- Specialists/experts in the field
- Public interest/policymakers

To know the terminology, we have created the Glossary for responsible exploration and mining which can be found on the project webpage

https://agemera.eu/toolsandresources/glossary

2.1 Tool 1: AGEMERA course

In Task 2.3, educational partners of AGEMERA are developing higher educational courses to increase awareness of CRMs and their significance in our everyday lives. The course will gradually become semester modules that will be included in the study programs of several universities). The course is related to specific critical raw materials such as rare earth elements (REEs) and battery raw materials (lithium, nickel, cobalt, graphite, etc.) and the way they affect our (Western, actually consuming) way of life. The course consists of geological and engineering information and discusses geopolitical issues, economic and marketing aspects, social and environmental concerns, etc. Students will be familiar with international frameworks and regulations, such as the United Nations Sustainable Goals (SDGs), the United Nations Framework Classification for Resources (UNFC) and the UN Resource Management System (UNRMS). The course has lectures about the uses of metals in our high-tech lifestyle and how fair and justified the supply of these metals can actually be within Europe concerning our dependence on imports and in the context of developing a strategy for gaining the social license to operate. In order to determine the updated awareness and social acceptance of CRM production within Europe and in specific territories, we launch questionnaires to assess the impact of courses.

Link to the course European Critical Raw Materials for the Green and Digital Transition (ECRMs), https://agemera.eu/our-work/university-courses.

The topics of lectures are listed in Table 3.

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Table 3. AGEMERA course lectures

AGEMERA course		
Title of the lecture	**Keywords**	**Extent (min)**
Geology of REEs and BRMs in Africa (Zambia)	Geology & Exploration of CRMs	90
Geology of REEs and BRMs in Europe	Geology & Exploration of CRMs	90
Conventional Exploration Technologies for REEs and BRMs	Geology & Exploration of CRMs	45
Minimal Invasive Exploration of CRMs and BRMs (Techniques used in AGEMERA)	Geology & Exploration of CRMs	45
The Green New Deal & CRMs	Geo-Politics & Challenges, Importance of CRMs	90
Mining in a Global Environment	Engineering Information	90
Social Assessment in Mining and Exploration	Social Assessment	90
Environmental Impact Assessment in the Extractive Sector	Environmental Assessment	90
Sustainable Finance	Economics & Marketing	90
SDGs, UNFC and UNRMS	International Frameworks	90
Introduction to the Technologies of OPT/NET	AI and Data Collection	45
Introduction to the Technologies of Muon Solutions	Muons	45
Introduction to the Technologies of Radai	Multi-Sensor Drones	45
International Reporting Standards	Standards	60

2.2 Tool 2: Micro degree

A micro degree, or micro degree study, is a longer continuing education programme with a comprehensive content based on one or more subjects. Itis a set of courses that gives a new set of competencies in a narrow field and with it, the ability to cope better in the labour market during complicated times.

Micro degrees offer industry-relevant knowledge and credentials which can potentially lead to better job opportunities and higher earning potential. Micro degrees are tailored to specific topics or industries. If specialized knowledge in a particular area is required, a micro degree can provide targeted learning.

The micro degree is a way to give lifelong learning in the selected field. Usually, the micro degree consists of 2 to 4 courses (10 to 25 ECTS) and can be given in one semester or one academic year as part of regular education activities in universities.

Example: Mineral resources circular economy micro degree (https://taltech.ee/avatud-ope/mikrokraadid/mineraaltoormete-ringmajandus), 18 ECTS by Tallinn University of Technology.

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The micro degree consists of three master-level courses: NGG0331 Mining in a Global Environment/ 6 ECTS/ autumn semester; EAV8300 LCA analysis/ 6 ECTS/ autumn semester; NGG0401 Circular Economy for Materials Processing / 6 ECTS/ spring semester.

Micro degree in AGEMERA

In the AGEMERA consortium, we have five universities: the University of Oulu, the University of Lapland, the University of Zagreb, the University of Zambia, and the Tallinn University of Technology. Each university has degree programmes in exploration, geology, mining, processing, etc. They would choose what courses they take to conduct the micro degree for AGEMERA topics. One course that should be involved is the AGEMERA course, which is developed in WP 2.

An example of an AGEMERA micro degree is from Tallinn University of Technology.

The selected courses are:
1) AGEMERA course
2) NGG0401 Circular Economy for Materials Processing / 6 ECTS/ spring semester

2.3 Tool 3: Public lecture

During the preparation of the AGEMERA course (in WP2), the course lectures are recorded and shared in AGEMERA activities as public lectures.

2.4 Tool 4: Workshop

Generally, the workshop is a focused and interactive learning session designed to impart knowledge, develop skills, or facilitate discussions on specific topics or subjects.

In the AGEMERA workshop, we are using our previous experience from developing an educational workshop for the understanding of raw materials in our lives. The selected toolkit is "Where does a fork come from?". During the workshop, we give information about the importance of CRMs in our everyday lives and link the small assignments with AGEMERA technology development and testing sites.

To run the AGEMERA workshop more easily, we have instructions, PowerPoints, and other materials prepared so that any partner organisation can deliver the AGEMERA workshop.

Facilitator instructions (Teacher Card) are shown in Figure 4 and on the webpage https://agemera.eu/our-work/raisingawareness/workshop/teachercard

To run the workshop and give the background information – the PowerPoint Presentation gives all the necessary information, as shown in Figure 5. To be engaged

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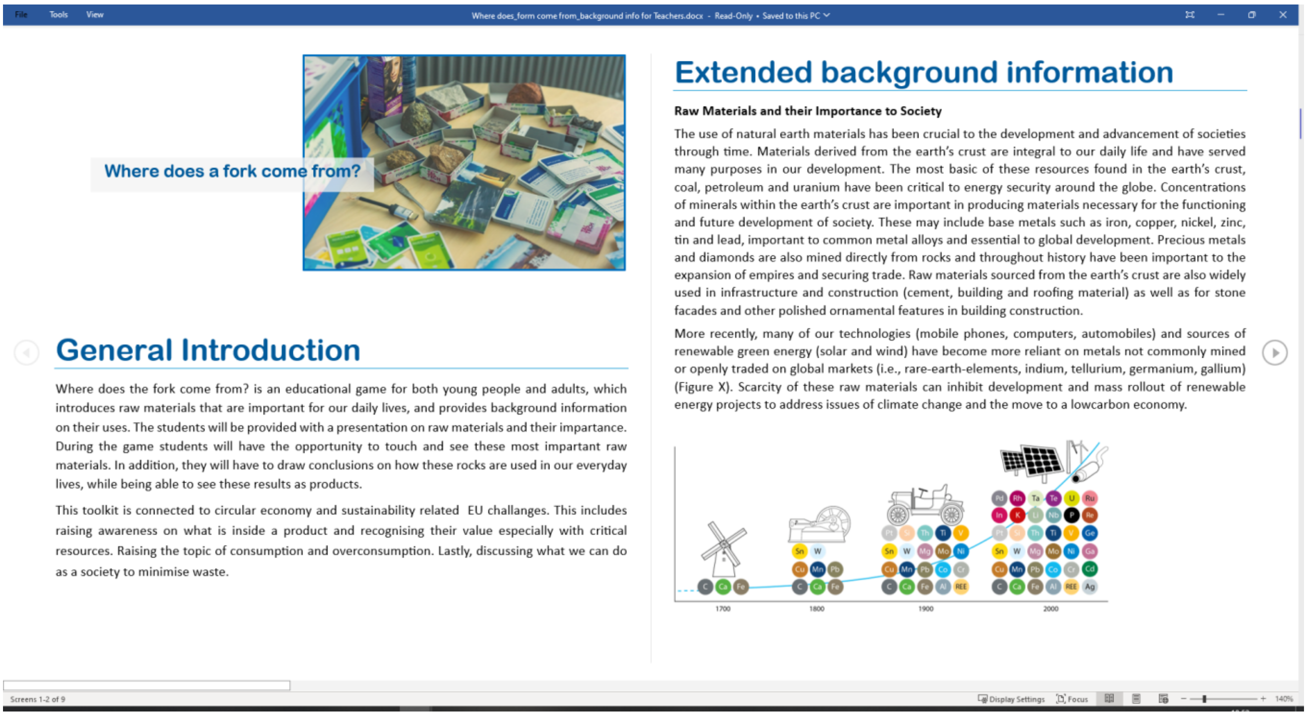
during the workshop, the participants need to discuss and make small assignments. For that, we have additional cards, shown in Figure 6.


Where does a fork come from?

General Introduction

Where does the fork come from? is an educational game for both young people and adults, which introduces raw materials that are important for our daily lives, and provides background information on their uses. The students will be provided with a presentation on raw materials and their impartance. During the game students will have the opportunity to touch and see these most impartant raw materials. In addition, they will have to draw conclusions on how these rocks are used in our everyday lives, while being able to see these results as products.

This toolkit is connected to circular economy and sustainability related EU challanges. This includes raising awareness on what is inside a product and recognising their value especially with critical resources. Raising the topic of consumption and overconsumption. Lastly, discussing what we can do as a society to minimise waste.

Extended background information

Raw Materials and their Importance to Society

The use of natural earth materials has been crucial to the development and advancement of societies through time. Materials derived from the earth's crust are integral to our daily life and have served many purposes in our development. The most basic of these resources found in the earth's crust, coal, petroleum and uranium have been critical to energy security around the globe. Concentrations of minerals within the earth's crust are important in producing materials necessary for the functioning and future development of society. These may include base metals such as iron, copper, nickel, zinc, tin and lead, important to common metal alloys and essential to global development. Precious metals and diamonds are also mined directly from rocks and throughout history have been important to the expansion of empires and securing trade. Raw materials sourced from the earth's crust are also widely used in infrastructure and construction (cement, building and roofing material) as well as for stone facades and other polished ornamental features in building construction.

More recently, many of our technologies (mobile phones, computers, automobiles) and sources of renewable green energy (solar and wind) have become more reliant on metals not commonly mined or openly traded on global markets (i.e., rare-earth-elements, indium, tellurium, germanium, gallium) (Figure X). Scarcity of these raw materials can inhibit development and mass rollout of renewable energy projects to address issues of climate change and the move to a lowcarbon economy.

Figure 4. "Fork Toolkit", Teacher Card

Figure 5. "Fork Toolkit", PowerPoint Presentation

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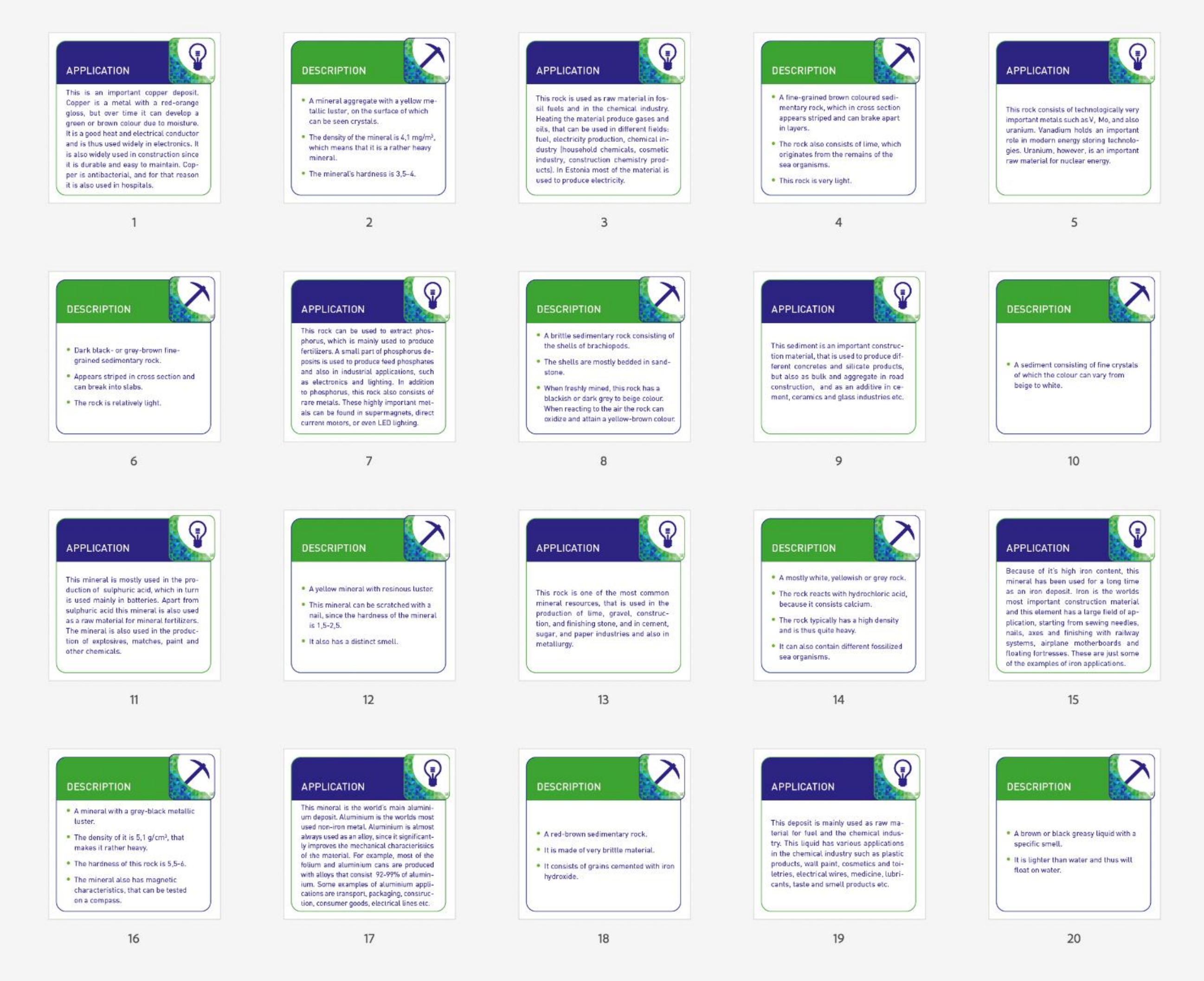

Figure 6. "Fork Toolkit", Workshop materials

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