European Economic and Social Committee

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Digital Mining in Europe:
New solutions for the sustainable production of raw materials

OPINION

European Economic and Social Committee

Digital Mining in Europe: New solutions for the sustainable production of raw materials
(own-initiative opinion)

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1. Conclusions and recommendations

1.1 The digitalisation of the EU raw materials sector is a singular opportunity to enhance the resilience of European industrial supply chains, to improve the environmental performance of the minerals sector and to increase transparency and dialogues with citizens and communities affected by mining activities.

1.2 Mining companies which started the digital transformation have seen improvements in safety, sustainability, productivity and margins. But the combination of enhanced connectivity, mobility, machine learning and autonomous operations raises ethical, social and regulatory questions that should be thought through by policymakers beforehand.

1.3 The EESC acknowledges that the digital transformation of the mining sector requires an ambitious effort to enact legal and regulatory changes, and that such effort should be made under the umbrella of supranational organisations/at international law level.

1.4 The EESC points out the importance of having a global, comprehensive minerals intelligence network structure to underpin the digital transformation and informed decision-making at the EU level. The EESC acknowledges the effort of the Joint Research Centre (JRC) in setting and maintaining an European raw materials information system.

1.5 The EESC considers that the digital transformation of the EU raw materials sector should be accompanied by data protection measures, and recognises the need for strictly enforced regimes to protect sensitive data.

1.6 The EESC recommends the development of an EU regulatory roadmap addressing the challenges created by the digital transformation of the raw materials sector, dealing with topics such as cybersecurity, artificial intelligence, automation, multi-level governance and sea and space mining.

1.7 The EESC recommends the definition and adoption of EU standards for the collection of data on mineral resources, and urges Member States to periodically collect and share comprehensive and verified data on the extraction, processing and recycling of raw materials with the JRC. This is important in assisting with the implementation of the EU Circular Economy Action Plan.

1.8 The EESC recommends setting up adequate social support measures designed to minimise the negative impacts that digital transformation will have on the mining workforce and to helping mining communities transition their economies to prevent the deepening of existing social inequalities between individuals and population groups.

1.9 The EESC recommends developing and supporting EU-based cloud infrastructure, in order to increase the level of security of 5G applications, cloud computing and Industrial Internet of Things platforms.

1.10 The EESC considers that the digitalisation of the mineral raw materials industry is crucial to tackle the economic crisis caused by the COVID-19 pandemic and to foster the implementation

of the European Green Deal and the EU Recovery Plan. In this context, it is paramount to stimulate investments in the digitalisation of the extraction and processing of primary (mining) and secondary (recycling) mineral raw materials.

1.11 The EESC calls on the European Commission to ensure that the social partners in the extractive sector are involved and consulted by the European institutions in the policy-making process and on any EU initiative affecting the mineral raw materials sector.

2. Introduction

2.1 The EU is facing technological, societal and environmental challenges related to the supply of raw materials that underpin its industrial activity and the quality of life for its population. The EU produces less than 5% of world production of mineral raw materials[1], and EU industry represents approximately 20% of the global consumption of mineral raw materials[2]. The EU dependency on imports is particularly high for rare metals and elements required for high-tech applications and for the green energy transition outlined in the European Green Deal (COM/2019/640). This substantiates the Raw Materials Initiative launched by the Commission in 2008 (COM/2008/699) and its successive efforts to assess the criticality of supply and list critical raw materials (the last list was published in 2017[3]; the updated list is part of the Commission's Communication on Critical Raw Materials[4].

2.2 Technological advances that boost the efficient use of materials and resources, and pushes towards waste reduction and recycling, in line with the EU Circular Economy Action Plan (COM/2015/0614 recently updated by COM/2020/98), are woefully insufficient to underpin societal needs and global population growth. In these circumstances, primary raw materials[5] will continue to play an essential role in the economy.

2.3 At the same time, public opposition to mining projects in many EU countries is increasing, and the industry's efforts to reduce its environmental footprint have not changed its (bad) reputation. Negative environmental impacts, lack of transparency and dialogue, and shortcomings on the distribution of economic benefits at the local level are features commonly attributed to the mining industry[6].

2.4 More recently, rising resource nationalism in raw material-producing countries and the COVID-19 pandemic have shaken EU industry's reliance on global supply chains. The EU

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1 Agricultural (e.g. potash) and energy minerals (e.g. uranium and coal) are not included in this assessment.

2 For additional information see *Eunomia, 2015. Study on the Competitiveness of the EU Primary and Secondary Mineral Raw Materials Sectors* (available at http://www.euromines.org/files/news/ec-report-study-competitiveness-eu-primary-and-secondary-mineral-raw-materials-sectors/study-competitiveness-eu-primary-and-secondary-mrms-april2015.pdf) and the *2018 EU Raw Materials Scoreboard*, published by the European Commission (available at https://op.europa.eu/en/publication-detail/-/publication/117c8d9b-e3d3-11e8-b690-01aa75ed71a1).

3 COM(2017) 490 final.

4 COM(2020) 474.

5 Primary raw materials refers to materials (minerals/metals) that are extracted from the ground and processed. Secondary raw materials refers to materials that are obtained through recycling processes.

6 Nevertheless, the mining industry has the support of mining communities and regions across Europe.

governments and many industrial producers realised that the import dependency on raw materials could wreck the EU manufacturing industry (the raw materials sector provides about 350 000 jobs within the EU, but there are more than 30 million jobs in downstream manufacturing industries that depend on reliable and unhindered access to mineral raw materials[7]).

2.5 Technological and communication advances have been pushing forward the integration of digital technologies into all business areas, fundamentally changing how companies operate and deliver value to customers. This is a unique opportunity for the EU mining sector: mining companies which leverage digital tools can reach new levels of performance across the value chain, with long-lasting positive effects on the socio-economic, environmental and social dimensions.

2.6 The digitalisation of the EU raw materials sector is a unique opportunity to enhance the resilience of supply chains, address radically different input economics and boost the operational, social and environmental excellence of the sector, advancing the concept of "digital mine".

3. General comments

3.1 Digitalisation in the raw materials production refers to the use of information technologies improving the acquisition, organisation and communication of data with the aim of enhancing the performance of production facilities in terms of technical, environmental and societal indicators.

3.2 Digital technologies harness all the available knowledge and enable continuous improvements as well as step-change innovations. An accurate understanding of interactions throughout production steps, inside and across value-chains and workforces enables resource-efficient production, equipment monitoring and maintenance, monitoring of health conditions and risk prevention, and emergency preparedness and response, among many other aspects.

3.3 The digital transformation is identified in the "Technologies for primary and secondary raw materials production" Priority Area of the European Innovation Partnership (EIP) on Raw Materials (COM/2014/297), in line with the EC's communication on *A New Industrial Strategy for Europe*. It defines raw materials as one of the key enablers for a globally competitive, green and digital Europe.

3.4 The EESC appreciates the role of the European Innovation Council and the European Institute of Innovation and Technology, which aim to boost the output of new services and products by European institutions. Initiatives involving raw materials underpin a significant proportion of these and interlink with other targets such as the energy and mobility transitions, advanced manufacturing, security, food and health. In particular, they also relate to the digital advance of technological solutions.

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7 For more information on the raw materials value added and jobs see the *2018 EU Raw Materials Scoreboard* (available at LINK).

3.5 The EESC supports the activities of the EU research group in creating a certification method for raw materials. This will be a push towards sustainable mining of minerals and metals, needed to underpin Europe's clean energy transition.

3.6 Identifying opportunities created by the digital transformation for the EU mining sector is a crucial part of the EESC's recommended approach to digital strategy. The identified opportunities should be assessed in terms of their potential value to organisations and society, and feasibility of implementation.

3.7 Social considerations

3.7.1 The digital transformation is already affecting traditional roles in the mining workforce, with the emergence of functions such as new technology specialists, data analysts and scientists, big data specialists, artificial intelligence (AI) and machine learning specialists and systems engineers, among others. As a consequence, routine tasks associated with roles such as plant operators, management and organisation analysts and extraction workers are expected to decline[8].

3.7.2 Due to the digitalisation of the sector and its transformation, employees must undergo appropriate training to be able to meet the challenges of Industry 4.0 and future technological changes.

3.7.3 Changes in the nature and composition of the workforce, alongside the implementation of a "work anywhere and anytime" model enabled by the digital transformation will have a significant impact on traditional mining communities in Europe. This calls for a proactive approach based on inclusive social dialogues to help communities understand their underlying capacities and support the transition of their economies toward new areas.

3.7.4 The EESC believes that, faced with the challenges posed by the digitalisation of the mining sector and the threats to the sector caused by COVID-19, the European Commission should support the current demands of the social partners in the mining sector at European level through the existing Sectoral social dialogue – Extractive industries.

3.7.5 The EESC calls on the Commission to ensure that the social partners in the extractive sector are involved and consulted by the European institutions in the policy-making process and on any EU initiative affecting the sector.

3.7.6 The EESC therefore believes that there is a need for the Commission, together with the social partners in the Sectoral Dialogue Committee, to set up as soon as possible at European and national level a network of Sector Councils for Skills and Employment in the extractive industries.

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8 McKinsey Global Institute, 2018. Skill Shift, Automation and the Future of the Workforce. Discussion Paper. McKinsey Global Institute, McKinsey & Company. https://www.mckinsey.com/featured-insights/future-of-work/skill-shift-automation-and-the-future-of-the-workforce (Accessed 3 June 2019).

4. Breakthrough concepts and solutions for sustainable exploration, mining and/or processing

- Ground-breaking concepts and solutions for exploring, extracting and recycling mineral raw materials are necessary to enhance Europe's position on the global stage. New approaches and technologies are expected to facilitate Europe's access to sustainably produced raw materials, while also gaining the trust of society in clean and safe extraction and processing methods.

- Knowledge on geological endowments, mineral deposits and their exploitation is disparate and variable, and the complexity of material cycles, policies, market trends, technological trends, environmental issues and societal impacts requires the combination of many fields of expertise to harness the benefits of digitalisation.

4.1 *Methods and tools for mineral intelligence*

4.1.1 Establishing a geoscience data hub for Europe

4.1.1.1 The availability, accessibility and recoverability of minerals, metals, energy and other subsurface resources are more than ever a crucial issue in contemporary society. The European Parliament, the EC and several EU initiatives in policy areas, e.g. the Raw Materials Initiative[9], the Groundwater Directive[10] and the Carbon Capture and Storage Directive[11] need access to relevant subsurface data.

4.1.1.2 The Joint Research Centre of the European Commission is currently developing a raw materials information system including economic, socio-economic and environmental dimensions – the RMIS 2.0[12]. However, the information provided is incomplete and does not cover all the EU 27 Member States with the same level of detail.

4.1.1.3 Today, data are only partially available and most of the time are not harmonised and thus are not comparable between countries. There is a need for standardisation of data formats and the development of algorithms able to serve as a bridge between different data systems.

4.1.1.4 In the EESC's view, the integration of a comprehensive mineral intelligence network structure, using harmonised reliable data, within the JRC RMIS is paramount; it would provide the EC and Member States access to information and knowledge to support the sustainable use of the EU subsurface in addressing Europe's challenges.

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9 Communication from the Commission to the European Parliament and the Council – The raw materials initiative: meeting our critical needs for growth and jobs in Europe (SEC(2008) 2741) / COM/2008/0699 final.

10 Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration.

11 Directive 2009/31/EC of the European Parliament and of the Council of 23 April 2009 on the geological storage of carbon dioxide.

12 See https://rmis.jrc.ec.europa.eu/

4.1.1.5 The EESC urges all EU Members States to collect and share raw materials information data to feed the JRC RMIS periodically. To prevent misrepresentations and errors, the EESC considers that the data provided to the JRC should be screened for accuracy before being included in the RMIS. The JRC should be funded to maintain and regularly update this information system.

4.1.2 Process simulation

4.1.2.1 Emissions, reclamation, water resource protection, etc. can all be subject to simulations: these can involve multiple parallel simulations using different assumptions on boundary conditions and starting points to give probability estimates of different outcomes that could be used for control and to support decision-making.

4.1.2.2 Developments on computational techniques for process simulation and the availability of big data (data sets with sizes beyond the ability of common software tools to capture, curate, manage, and process within a tolerable elapsed time) boosted the accuracy of simulations that represent causal relationships between controlled inputs and corresponding outputs. Process simulations can prove especially relevant in environmental and safety assessments and could facilitate transparency and dialogues in permitting processes.

4.1.3 Remote sensing

4.1.3.1 The use of remote sensing data made available by, for example, the Copernicus programme , encompassing spatial data analytics and integration with geographic information systems (GIS) software can be a valuable input into advanced simulations and the creation of "digital twins", that allow quick responses to changes and reliable decision-making. The combination of remote sensing data with field data collected by sensors and drones is increasingly common in the mining sector. Land and underwater surveying using drones, for estimating stockpiles and waste dumps, are routinely made in many mining operations.

4.1.3.2 The integration of remote sensing data with field data (from local sensors) in GIS software can be used to monitor groundwater levels, landmass movements, surface water contamination and many other real-time environmental data. If made public and protected against manipulation (e.g. by technologies such as blockchain), this data could boost trust in the mining sector and facilitate dialogues with stakeholders. Long-established data and information management practices in developed countries with a strong mining sector, such as Canada or South Africa, could be considered and serve as examples.

4.1.4 Virtual Reality

4.1.4.1 Virtual reality is becoming routinely used by many companies in the interpretation of 3D models of their mines. What may be more significant in the future is Augmented Reality in which geologists or engineers, while in the mine, can use a device to see the model superimposed on their view of the geology or the mine itself. This provides an advanced and powerful means of validating models as well as checking on the progress of mine development.

4.1.4.2 Virtual reality is increasingly being used by universities and training centres to immerse students and trainees in "real-life" mining contexts. The possibility of running educational simulations designed to facilitate the construction of practical knowledge in areas such as response to accidents is one of the main advantages of this technology.

5. **The "smart mine"**

- Digitalisation is the catalyst that helps mining operations become "smarter" by leveraging digital tools and processes that make operations instrumented, interconnected and intelligent.

- Mines will be, through digital transformation, designed differently for automation from inception with methods tailored and scaled to the orebody and variation in execution reduced by automation.

- The digital transformation will help eliminate fatalities and injuries from mining environments. It can result in a step-change in capital intensity and operating costs, provide access to resources from mineral deposits that could not previously be mined, and generate a lower environmental footprint through selective mining.

5.1 *Intelligent mining prediction*

5.1.1 Prediction means, among other things, forecast of environmental parameters in which miners work, with particular emphasis on hazards. Effective prediction systems already being used by the mining industry include predictive maintenance, to prioritise preventive action over repairs, by collecting data on machine use and process parameters.

5.1.2 Prediction can play a significant role in the safety of mine operations. The capture and integration of monitoring field data and equipment data can provide an accurate picture of the operations environment to be screened by process analysis tools. This would become a relevant enhancement of working conditions, especially for underground mines. The EESC believes that digitalisation can effectively contribute to the safety of mining operations and that a smart mine should include prediction systems.

5.2 *Internet of Things*

5.2.1 The development of standards and building blocks for an Industrial Internet of Things (IIoT) platform for the mining industry could boost the connection of cyber and physical systems in EU mines, in order to improve decision-making processes.

5.2.2 The IIoT platform should address health and safety aspects, environmental performance, resource efficiency and real-time coordination of operations. The design and promotion of an EU IIoT platform for the mining sector should be prioritised.

5.2.3 To avoid cybersecurity risks, the EESC suggests that the building blocks of the IIoT platform should be designed for local Intranets of Things, connected either through physical data transfer or through secure firewalls to the internet.

5.3 *Blockchain technology. Supply chain transparency*

5.3.1 Blockchain is an innovative solution that prevents data manipulation. Using blockchain in the mineral raw materials supply chain has the potential to improve supply chain transparency and traceability as well as reduce administrative costs. The EESC points out that blockchain technology facilitates compliance with the EU Regulation on Responsible Sourcing of Minerals (Regulation (EU) 2017/821 of the European Parliament and of the Council of 17 May 2017).

5.3.2 Other applications of blockchain include the collection and dissemination of environmental data. By enhancing the confidence in the data, blockchain could facilitate public outreach and engagement in the vicinity of mining communities.

5.4 *5G networks and cloud computing*

5.4.1 Cloud storage of raw data is rapidly becoming impractical (and is actually unnecessary) as the volume of data increases to terabytes and more. Today, the speeds of data transfer limit its usefulness. However, the adoption of 5G networks will change this, allowing the rapid transmission, processing and cost-efficient storage and retrieval of big data.

5.4.2 There is a severe risk in using cloud storage: if a mining company uses a commercial cloud storage service, the level of security it can achieve is entirely a function of the trust it places in the service provider. Many providers use cloud servers located outside the EU, and this can jeopardise the system security. The EESC believes that the adoption of 5G in the EU should be accompanied by incentives to increase the offer of EU-based cloud providers.

5.5 *Cybersecurity*

5.5.1 The EESC is in favour of strictly enforced regimes preventing sensitive data from leaving security boundaries. Cybersecurity can be significantly enhanced by not connecting mine systems to the internet. The smart technologies can all be used in the "smart mine", including an Intranet of Things – just not made accessible from outside. Anything that needs to be connected to corporate HQ or the outside world should be transferred securely from the mine network to a separate server that is connected to the outside world.

5.6 *Artificial intelligence*

5.6.1 Artificial intelligence covers a range of different technologies, including so-called deep-learning systems. So far it has found niche applications in areas such as image processing (such as for mineral exploration), and neural-network systems for mineral identification and classification. Other practical applications for the mining sector include analytics and machine learning algorithms being used in process simulations and prediction systems.

5.7 *Integrated automation*

5.7.1 The technology of driverless vehicles is being developed rapidly by actors unconnected to the mining industry (such as Tesla or Google). Still, because mines are controlled environments, it can quickly be deployed in mines as new capabilities are introduced. Other forms of automation may also be deployed rapidly, but usually take the form of remote human-controlled (and computer-assisted) operations rather than fully autonomous operations. Because of liability concerns (and prospective regulations), it is questionable whether development of full automation of all mining processes will be economically viable in the short-medium term.

6. Building sustainable and responsible strategic partnerships with third countries

- The EU criticality assessment shows that greater diversification of critical raw materials imports from third countries is essential.

- There is a need for enhanced strategic economic diplomacy at the EU level to diversify access to resources based on sustainable sourcing of raw materials.

6.1 *Research and innovation*

6.1.1 The EU research and innovation framework programmes already foster international cooperation with third countries in calls linked to mineral raw materials. However, a more prescriptive approach to further collaboration with resource-rich and technologically advanced countries on the digital transformation of mining (such as Australia, Canada, Japan, South Africa and the United States) would be instrumental in building connections that would favour EU economic diplomacy. The EESC recommends the adoption of such prescriptive approach in the coming Horizon framework.

6.1.2 Education should also be used as an instrument to support EU economic diplomacy on raw materials topics. Internationally recognised education programmes, made in Europe, delivering ground-breaking and innovative educational contents focused on mine digitalisation topics could become an effective instrument of EU economic diplomacy.

7. New frontiers

7.1 *Recovery of metals and minerals from sea resources*

7.1.1 There is much research on technological solutions for the extraction and processing of minerals and metals from sea resources, including seawater brines, and/or from the seabed. The EESC considers that the mining of minerals and metals from the sea should undergo a strict assessment of the corresponding environmental impacts.

7.2 *Use of space resources*

7.2.1 By 2025, the European Space Agency is planning the extraction of resources that can help sustain lunar stays and research. Potential lunar resources encompass processable materials such

as volatiles and minerals (for construction, radiation and micrometeoroid protection), along with geological structures such as lava tubes that together might enable lunar habitation.

7.2.2 Space mining raises legal questions to which there is currently no clear answer, as the scarce body of international law applicable to outer space activities lags behind the advances in technology fuelling the space industry. The EESC considers that the EU should fill this gap and take the lead to define a stable and internationally accepted legal framework that ensures a fair, secure, responsible and sustainable use of space.

8. Beyond the COVID-19 crisis

8.1 The COVID-19 global pandemic is highlighting the importance of digital transformation. In these times of increasing instability and unpredictability, mining operations worldwide have had to grapple with the threat of total shutdowns or a reduced workforce, the likelihood of which continues to rise as the coronavirus spreads.

8.2 The EESC believes that, considering the challenges posed by the digitalisation and the threats to the mineral raw materials industry caused by the COVID-19 pandemic, the European Commission should promote comprehensive dialogues among social partners through the existing sectoral social dialogues (extractive industries) mechanism.

8.3 What will be a major question going forward is how the mining companies use and engage with digital technologies, which have become intertwined with how many companies are dealing with the pandemic. Entire labour forces are having to work virtually and embrace new technologies, while social distancing orders mean that remote monitoring of operations has never been more necessary.

8.4 The EU and the Member States must support the digital transformation of the EU mining sector actively. This is a crucial step to increase the resilience of the EU industry and the raw materials value chain. Mines using digital technologies, including integrated automation, cognitive network and use of real-time analytics are more efficient, clean and safe. Reduced environmental footprints and safer environments are easier to obtain in "smart mines", and this is crucial to get the social licence to operate in Europe.

Brussels, 18 September 2020.

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The president of the European Economic and Social Committee