



European  
Commission

# Business Innovation Observatory



## Sustainable Supply of Raw Materials



## Innovative mineral and metallurgical extraction and processing

*Case study 59*

Internal Market,  
Industry,  
Entrepreneurship  
and SMEs

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# **Sustainable Supply of Raw Materials**

Innovative mineral and metallurgical extraction and processing

Business Innovation Observatory  
Contract No 190/PP/ENT/CIP/12/C/N03C01

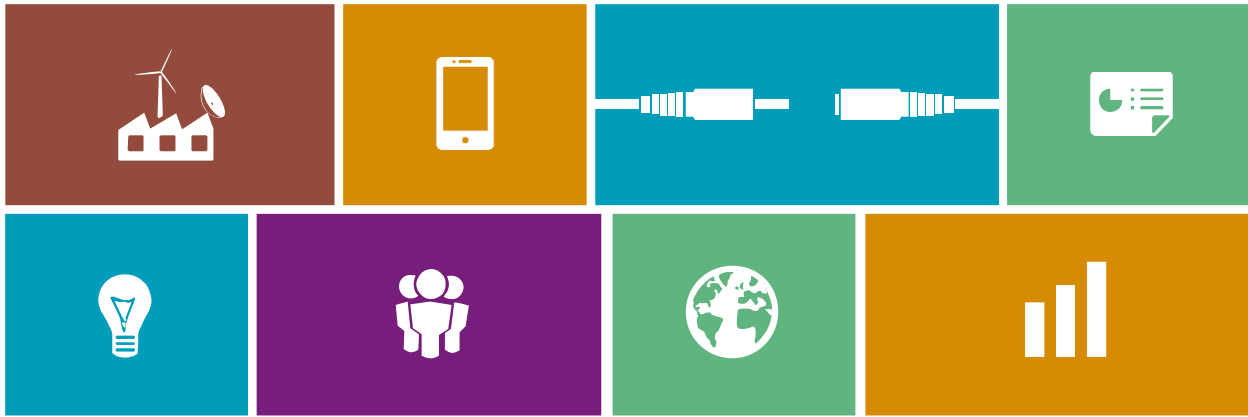
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European Union, February 2016

# Table of Contents

1. Executive summary	2
2. Innovative mineral and metallurgical extraction and processing	3
2.1. Trend presentation	3
2.2. Overview of the companies	4
3. Impact of the trend	6
3.1. The market potential of the trend	6
3.2. Societal impact of the trend	7
4. Drivers and obstacles	9
4.1. Uptake of innovations is problematic	9
4.2. Market lacks proper communication and trust between relevant stakeholders	9
4.3. Mining in Europe is becoming technically more demanding	10
4.4. Energy and labour costs are higher in Europe	10
4.5. Environmental regulations in Europe are stricter than in competing markets	10
4.6. Lack of knowledge about mineral endowment and the sector	11
4.7. Raw materials are vital for modern-day technologies	11
4.8. Dedicated EU initiatives help drive innovation	11
4.9. Europe is at the forefront of the latest innovations	11
5. Policy recommendations	12
5.1. Create a minerals and metals knowledge base within the EU	12
5.2. Facilitate market entry through networking events	12
5.3. Develop a common EU framework for the mining sector	12
6. Appendix	14
6.1. Interviews	14
6.2. Websites	14
6.3. References	14



# 1. Executive summary

This case study focuses on innovative mineral and metallurgical extraction and processing, more precisely the automation of extraction and processing as well as various innovative solutions allowing to reduce the environmental footprint of mining by decreasing *i.a.* energy and water consumption.

The competitiveness of the European mining industry is being challenged by the depletion of easy-to-access raw materials in Europe, the increased production costs and the EU rules on environmental impact of mining and occupational health and safety.

Ensuring a safe and sustainable supply of raw materials while increasing benefits for society as a whole is one of the key objectives of the European Innovation Partnership on Raw Materials. Sustainable supply of raw materials is fundamental for increasing Europe's production and the maintenance and improvement of quality of life. As an example, the construction, chemicals, automotive, aerospace, machinery and equipment sectors, which depend on these materials, have a combined added value in excess of EUR 1,000 billion and provide employment for some 30 million people in the EU.

The economic potential of innovative mineral and metallurgical extraction and processing solutions is promising. After the negative growth rates between 2011 and 2014, it has been forecasted that the European metals and mining industry would increase by 19.3 per cent between 2014 and 2018, reaching a market value of USD 477.1 billion by 2018. Furthermore, the value of unexploited European mineral resources at a depth of 500-1,000 metres is estimated at about EUR 100 billion.

Innovative extraction and processing solutions also have considerable socio-environmental repercussions. Their

integration in the minerals and metals value chain entails important energy and water savings as well as significant improvements in the quality of mining effluents. Automation of underground mining is one of the most promising technologies to prevent accidents as it allows removing personnel directly from hazards. Furthermore, the unrealised mineral wealth constitutes a potential source of employment in Europe.

Today the uptake of innovative extraction and processing is driven by the ever-increasing demand for solutions to decrease the environmental footprint of mining activities. Dedicated EU initiatives and the fact that minerals and metals are the basis for the majority of industrial production processes were identified as strong drivers for the adoption of some of the valorised solutions. Additionally, Europe benefits from being at the forefront of innovations in the mining sector.

Among the key challenges faced by the sector are health and safety considerations. Further obstacles include communication and trust issues between relevant stakeholders, the large depletion of easy-to-access raw materials in Europe, higher energy and labour costs with respect to companies in competing countries, and strict environmental and health regulations. Given the high investment and high-risk nature of mining, companies in the industry are generally reluctant to adopt new solutions.

Therefore, to unlock the large potential of innovative mineral and metallurgical extraction and processing solutions, action at the EU level is required. It is recommended to create a European minerals and metals knowledge base, to facilitate market entry for new comers and to develop a common EU framework for the mining sector.

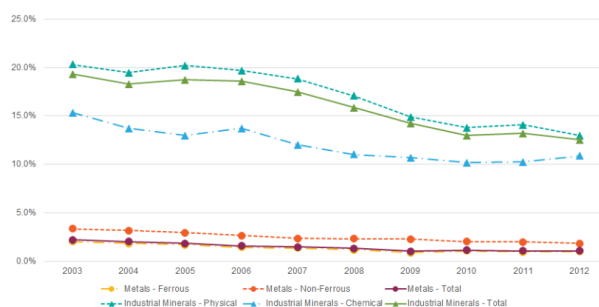


## 2. Innovative mineral and metallurgical extraction and processing

### 2.1. Trend presentation

Innovative solutions for mineral and metallurgical extraction and processing are necessary to reduce Europe's dependence on the import of raw materials. Ensuring an efficient and safe supply of metals and minerals is fundamental for increasing Europe's production and the maintenance and improvement of quality of life. Over 30 million jobs in the EU and many key economic sectors such as the automotive, aerospace, and renewable energy sectors depend on a sustainable supply of raw materials<sup>1</sup>.

Figure 1: EU-28 share of global output by sub-group



Source: British Geological Survey<sup>2</sup>

This case study is one of three on the sustainable supply of raw materials, and is on innovative mineral and metallurgical extraction and processing. More precisely, the **automation** of extraction and processing as well as various innovative **solutions**. Other innovations include the **reduction of the environmental footprint** of mining by decreasing, for instance, energy and water consumption.

Resources in Europe have been actively mined over many centuries and a majority of **easy-to-access mineral deposits are largely depleted**<sup>3</sup>. Furthermore, the mining industry faces challenges related to low-grade ore reserves, higher energy requirements and production costs, water shortages and increasing environmental regulations. This calls for the development of cost-effective tailor-made solutions for **environmentally friendly mining and processing in difficult conditions and extreme environments**. Such solutions should allow to tap into the large potential of yet untouched raw materials in.

There are indeed major opportunities for innovative mineral and metallurgical extraction and processing at greater

depths, in remote as well as populated areas, in former mine sites, in low-grade deposits and in small deposits where larger mining operations might not be feasible. Hence, the need for the mining industry to develop pioneering solutions and a modern structure that can exploit these minerals and promote both greater productivity and safer working conditions.

Figure 2: Largest iron ore mine in Central Europe



Source: TOMRA Systems ASA<sup>4</sup>

The market for innovative and sustainable solutions in the mining industry is nascent. A global challenge for companies active in this sector is to get the mining industry, traditionally a **conservative industry**, to recognise the value of innovation in securing a sustainable future for the industry in Europe. Mining companies typically only consider change or implementing new practices or techniques once these have become well established and proven.

Weaknesses for the European mining environment include highly complex and often unevenly implemented regulations, notably a strong emphasis on social and environmental protection, which can discourage investment.

Compared to its competitors, the mining sector in the EU-28 has some advantages, including an excellent transport network and infrastructure which facilitate the movement of goods from places of extraction to locations where they are used. Another advantage is an overall strong support for research and innovation activities, combined with a solid network of academic facilities that provide a favourable environment for the development of new technologies<sup>3</sup>.



## 2.2. Overview of the companies

**Table 1: Overview of the company cases referred to in this case study**

Company	Location	Business innovation	Signals of success
Abillion Oy	Finland	Abillion Oy develops ultrasonic cleaning solutions to eliminate and/or prevent scaling in harsh conditions.	<ul style="list-style-type: none"> <li>- Received funding and other support from Tekes, the Finnish Funding Agency for Innovation</li> <li>- Products are used by several large multinational companies that operate in Finland (e.g. Pyhäsalmi Mine and Agnico Eagle)</li> </ul>
AGQ Mining & Bioenergy S.L.	Spain	AGQ is an analytic laboratory and technological centre offering solutions to decrease the environmental impact of mining effluents.	<ul style="list-style-type: none"> <li>- One of the consortium partners of the EU Horizon 2020 project INTMET</li> <li>- ANS/ISO/IEC 17025 for mining laboratory analyses</li> </ul>
KGHM Polska Miedź S.A.	Poland	KGHM is focusing on copper ore mining and on the production of copper, precious metals and other non-ferrous metals. The company is heavily investing in the implementation of the concept of a so-called Intelligent Mine.	<ul style="list-style-type: none"> <li>- Winner of the Polish 'Innovum - Leader of Innovation' statuette</li> <li>- National winner of the Randstad Award 2015</li> <li>- Third largest producer of silver and the eight largest of copper in the world (2014)</li> <li>- Involved in multiple projects financed under the EU framework programme such as the EIP on Raw Materials, Biomine, PROMINE, I2Mine, IRIS</li> <li>- Partnerships with multiple leading R&amp;D institutions and universities such as the AGH University of Science and Technology in Kraków, Wrocław University of Technology, the Mineral and Energy Economy Research Institute of the Polish Academy of Science, the University in Lund and Lulea in Sweden</li> <li>- Co-founder of the CuBR Sectoral Research Program (Poland)</li> </ul>
TOMRA Systems ASA	Norway	TOMRA Sorting is the leading provider of sensor based sorting equipment for recycling, food, mining and specialty products. These sorting solutions enhance optimal resource-productivity.	<ul style="list-style-type: none"> <li>- Winner of the European Business of the Year Award with Turnover of EUR 150 million or higher in 2015.</li> <li>- Market leader in sensor-based ore sorting (estimated 40-50 per cent market share)</li> <li>- Constituent of the Ethibel Sustainability Index (ESI) Excellence Europe</li> <li>- Partnership with leading R&amp;D institutions and universities: SINTEF, CTR, Fraunhofer ILT; universities like RWTH, Aachen and Brussels</li> </ul>

**Problem 1** – As easy-to-access resources have largely been mined out in Europe, mining companies have to dig deeper. Working conditions near the face of the mine are becoming increasingly difficult, notably due to high temperatures, gas risk and rock stress.

*Innovative solution 4* – KGHM Polska Miedź S.A., a Polish mining company, is very active in the research and development of solutions that allow digging deeper while not compromising the safety of the miners. The company's Intelligent Mine project aims at developing a fully integrated Intelligent Production Process, ensuring safety, technological effectiveness and efficient and flexible management of all production operations. Specifically, it aims at increasing

safety and substituting human beings in most dangerous places with robots or autonomous systems, and tackling the new types of hazards.

A concrete example of a project developed under the Intelligent Mine are the processes related to securing the roof of the underground mine. At the moment of the mining process when the rock blasting has been done, the roof of the mine needs to be secured in order to be able to move farther. This used to be one of the most dangerous moments in the shaft because the risk of rock falling was extremely high. In collaboration with its subsidiary KGHM ZANAM and the Wrocław University of Technology KGHM Polska Miedź has developed a machine that helps automate this process. The company aims at fully automating this



process so that no human being has to be in the mine when the bolting is done.

#### Roof bolter in low height ore horizon



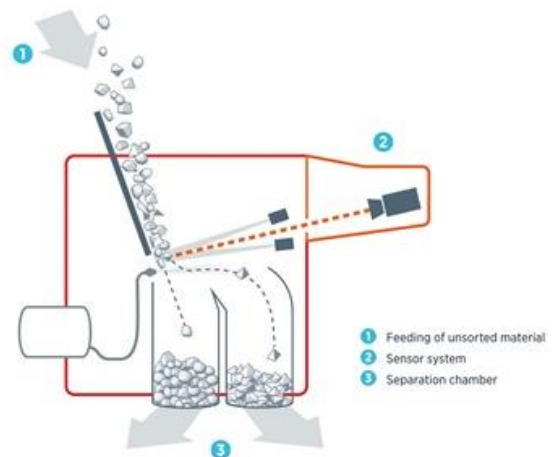
Source: KGHM Polska Miedź S.A.<sup>5</sup>

**Problem 2** – Given that most mines are very far away from where the minerals are processed, transportation costs consume a significant part of the total material value. Furthermore, the beneficiation process, which aims at removing the gangue mineral from ore to produce higher-grade product, is very energy intensive.

*Innovative solution 2* – TOMRA Systems ASA, a Norwegian multinational, offers sensor-based sorters for the beneficiation process that can reduce energy consumption by 15 per cent and the amount of water used by three to four cubic per tons of ore<sup>6</sup>. If the ore extracted from mines is immediately sorted on-site to reject waste rock from the run-of-mine ore, the mass to be transported decreases significantly. Consequently, transport costs and CO<sub>2</sub> emissions are considerably lower and the extractor gets a better price because the commodity is of higher concentration. For the beneficiation process, this benefits from a decreased energy consumption (the crushing process is very energy intensive) and a lower service amount as less spare parts need to be replaced.

Another important characteristic of these sensor-based sorting solutions is that they increase access to resources. Indeed, they allow making mines profitable which were not anymore because of too low head grade, i.e. too low metal and mineral content in the ore.

#### Simplified scheme of TOMRA's sensor-based sorting solution



Source: TOMRA Systems ASA<sup>7</sup>

TOMRA's sensor-based sorters are especially efficient because they cover a broad range of sorting tasks. They can be broadly divided into two different system types:

- Reflection systems including technologies like optical cameras which identify particles based on surface properties;
- Transmission systems like X-ray transmission which detect particles based on density differences.

**Problem 3** – Pipe scale causes clogging and requires costly clean-outs.

*Innovative solution 1* – Abillion Oy is a Finnish importer and developer of cleantech solutions in Baltic countries as well as Germany. Abillion Oy is developing acoustic cleaning and scaling prevention solutions that eliminate and/or prevent biological growth and mineral scaling in harsh conditions, such as tanks and pipes filled with slurry.

The prevention of scaling enhances operational efficiency. Further advantages include:

- Reduction of maintenance costs (decreased process down time (less time needed for cleaning), less work and less chemicals needed);
- Improved energy efficiency because if there is, for instance, scaling on a pipe, the resistance increases and so the energy consumption too.





*Difference between pipes without ultrasonic cleaning solution and pipes with ultrasonic cleaning solution after running for 3 and 6 months*



Source: Abillion Oy<sup>8</sup>

**Problem 4** – Mining and metallurgical processes may generate effluents containing elevated concentrations of toxic compounds which pollute water. Some rocks mined contain sulphides. When the latter are processed they may produce thiosalts which eventually oxidise into sulphuric acid, which has a harmful impact on the environment.

*Innovative solution 3* – The Spanish company AGQ Mining & Bioenergy SL offers solutions for the treatment of mining effluents by a biological process that minimises or eliminates their potentially harmful impact on the environment.

In collaboration with the Group of Biohidrometallurgy of the University of Seville, they have designed a continuous process of chemical-bacterial oxidation of thiosulphate or

tetrathionate solutions separately or solutions with presence of both salts. Instead of using mostly expensive chemicals that have to be transported to the mining site, AGQ Mining & Bioenergy SL's process is catalysed by bacteria that are present in the environment of the mine. This presents an obvious cost advantage.

*Biooxidation column*



Source: AGQ Mining & Bioenergy SL<sup>9</sup>

## 3. Impact of the trend

Securing a sustainable supply of raw materials is a key priority for the EU. As mentioned earlier, numerous jobs in the EU and many key economic sectors, such as automotive and aerospace, depend on the safe and sustainable supply of raw materials.

Innovative extraction and processing methods will help the European mining industry to foster growth and competitiveness to sustain the current incipient economic recovery and to reach the European Commission's aspiration of increasing the contribution of industry to GDP to 20 per cent by 2020. Hence, businesses that offer a means to provide added value in this strategically important market stand to benefit from this, helping to generate economic growth while limiting the environmental footprint of the mining industry.

### 3.1. The market potential of the trend

**Innovations improve access to previously difficult to reach raw materials.**

Given the large depletion of easy-to-access raw materials in Europe, the increased production costs and the EU rules on environmental impact of mining and occupational health and safety, there is an important market potential for pioneering solutions that reduce the environmental footprint of mining activities, increase access to resources, enhance workers' safety and eventually increase overall efficiency of the sector. Indeed, given all the above, it is crucial for the European mining industry to innovate in order to compete on the market.

The value of unexploited European mineral resources at a depth of 500-1,000 metres is estimated at about EUR 100 billion<sup>10</sup>. Hence, there is potential through greater innovations, such as the ones presented in the previous section, to further exploit European mineral resources.





*“The less concentrate in a mine the more meaningful it is to do sorting.” – TOMRA Systems ASA*

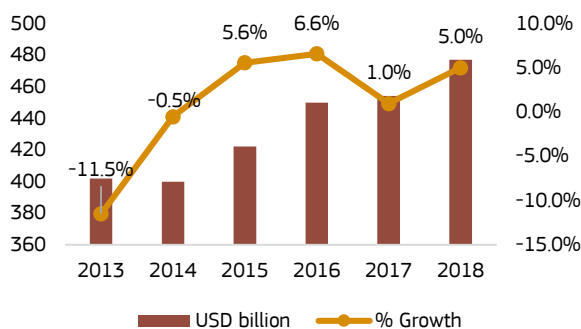
Sensor-based sorters, for instance, increase access to resources: TOMRA’s sorters allow increasing concentration of metals and minerals so that some mines which would have otherwise been closed because of too low a head grade, can instead remain profitable to operate.

TOMRA Systems ASA forecasts a 15 per cent growth of the sales of its sensor-based machines until 2018. However, the company insists on the fact that sensor-based sorting is still a technology to be accepted and growth has been limited in recent years.<sup>11</sup>

### The European mining and quarrying market has a large economic potential.

The recent economic crisis has re-confirmed that the mining industry is cyclical and highly affected by macroeconomic conditions.<sup>12</sup> The industry suffered significant losses due to the economic crisis and the ensuing decrease in commodity prices: the European metals and mining industry reached a market value of USD 402 billion in 2014, which was an 11.5 per cent decrease compared to 2013.<sup>12</sup> Overall, the compound annual growth rate of the value of the European metals and mining industry between 2009 and 2013 was 7.2 per cent.

**Figure 3: Forecasted market value of the European metals and mining industry**



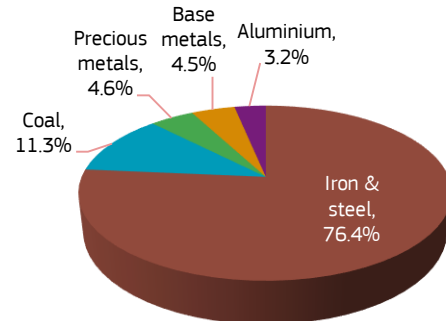
Source: MarketLine<sup>12</sup>

MarketLine forecasts a market value of USD 477.1 billion for the European metals and mining industry in 2018 (Figure 3), namely an 18.7 per cent increase against 2013. In terms of volume, this equates some 1,432 million metric tons by 2018, an increase of 5.3 per cent since 2013.<sup>12</sup> A growing population and increased standards of living and urbanisation can explain this surge in demand and market potential.

In 2013, the largest producer in the European metals and mining industry was Germany (15.6 per cent), followed by Italy (5.6 per cent) and France (4.3 per cent).<sup>12</sup>

Over three quarters of the industry’s total value came from iron and steel in 2013 (76.4 per cent), followed by coal with 11.3 per cent (Figure 4).<sup>12</sup>

**Figure 4: Europe metals & mining industry category segmentation (2013)**



Source: MarketLine<sup>12</sup>

### The mining and quarrying market is quite complex.

Concerning the market rivalry, the metals and mining industry is quite complex, with large size companies operating next to smaller ones.<sup>12</sup> According to the latest Eurostat data, nearly two-thirds of the companies in the mining and quarrying sector employed at least 250 people in 2012.<sup>13</sup>

## 3.2. Societal impact of the trend

Environmental risks of non-sustainable mining are numerous and include erosion, formation of sinkholes, loss of biodiversity as well as the contamination of soil and water by chemicals from mining processes. The contamination of soil and water can also affect the health of the local population.

Innovative mineral and metallurgical extraction and processing solutions can improve the quality of workplace and decrease fatalities by removing the need for physical labour in dangerous or otherwise unhealthy environments. Additionally, they will reduce negative impacts on the environment.

### Innovative extraction and processing solutions reduce water and energy consumption of the mining industry.

Mining and quarrying are highly **water-intense** activities, both in terms of total volume and value added. The innovative solutions developed by the showcased companies will have a positive impact on the quality of industrial waste water and the consumption of water: TOMRA’s sensor-based dry sorters contribute to a decrease in the water consumption of the mining and quarrying sector and AGQ Mining & Bioenergy SL’s bacterial solutions will lead to less acid mining effluents.

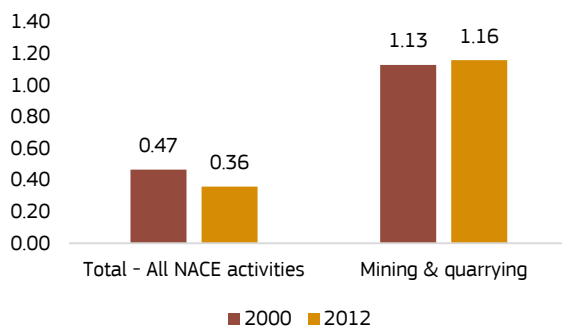


Germany accounts for the highest value of per capita water use in mining and quarrying (104 m<sup>3</sup> in 2010) in the EU, while Lithuania registers the lowest (0.2 m<sup>3</sup> in 2011). In 2010, fresh surface and groundwater abstraction for mining and quarrying ranged from 0.9 million m<sup>3</sup> in the Netherlands to 2,122.3 million m<sup>3</sup> in Germany.<sup>14</sup>

### The extraction and processing of metals and minerals are very energy-intensive.

The ratio of greenhouse gas emissions (in kilograms of CO<sub>2</sub> equivalents) to the gross value added (in EUR) measures the gas intensity in economic activities. Figure 5 shows that the greenhouse gas intensity for all NACE\* activities has decreased by 23.2 per cent between 2000 and 2012 while in the mining and quarrying economic activity it increased by 2.7 per cent.<sup>15</sup> This emphasises the need for the mining and quarrying industry to adopt solutions which allow decreasing the greenhouse gas intensity.

**Figure 5: Greenhouse gas intensity of the EU-27 by economic activity (kg of greenhouse gas per EUR)**



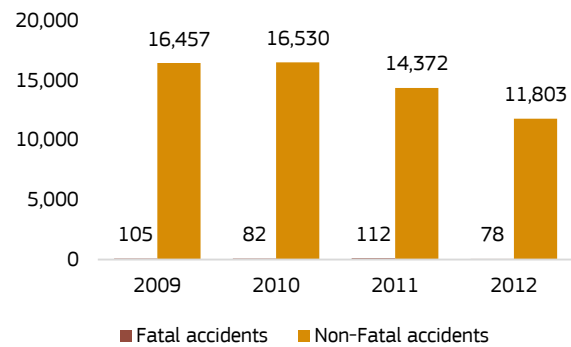
Source: Eurostat<sup>15</sup>

### Automation of underground mining is one of the most promising technologies to prevent accidents.

The mining industry is one with a more elevated risk of accidents leading to injury or death. In the past, work-related health problems and accidents often occurred in this sector. Over the years, with the introduction of vastly safer and more productive mining machines and systems, ever-safer mining methods and a growing awareness of the importance of effective accident prevention programs among both management and miners led to a reduction in **accidents** in the mining extraction.<sup>16</sup>

In 2012, there were 11,803 non-fatal accidents in the EU-28. The number of fatal and non-fatal accidents in the EU-28 has gone down since 2009 (Figure 6).

**Figure 6: Accidents in mining and quarrying (EU-28)**



Source: Eurostat<sup>17</sup>

Fatal accidents are on average more frequent in mining and quarrying than in other economic activities. In 2012, mining and quarrying represented 0.4 per cent of all non-fatal accidents of NACE activities and 2 per cent of all fatal ones.<sup>18</sup>

Automation of underground mining is one of the most promising technologies to prevent fatal mining accidents because it allows to keep humans out of harm's way.

### Unrealised mineral wealth constitutes a potential source of employment in Europe.

Unemployment has increased sharply in Europe as a result of the economic crisis. The employment rate in the EU stood at 68.4 per cent in 2012 compared to 68.5 per cent in 2010 and is expected to remain below the Europe 2020 target of 75 per cent of the population aged 20-64 by 2020. Today, the countries with the highest unemployment are Portugal, Slovakia, Poland, Romania, Ireland, Bulgaria, Hungary, Italy, Spain, Croatia and Greece. Almost all of these countries have significant unrealised mineral wealth and mine permits pending. According to a recent analysis by Euromines, Greece, Portugal and Romania, in particular, stand to gain and create wealth from the recent upsurge in demand for metals and minerals.<sup>19</sup>

\* NACE is the Statistical classification of economic activities in the European Community (from the French *Nomenclature statistique des activités économiques dans la Communauté européenne*).



## 4. Drivers and obstacles

Despite strong market potential and important societal impact, the uptake of innovative mining solutions is slow. Challenges that the mining industry and companies developing solutions for them face include safety and risk considerations, large depletion of easy-to-access raw materials, communication and trust issues, strict environmental regulations as well as high energy and labour costs. Drivers for the uptake of innovative mining solutions include the dependence of the EU's economy on a safe and sustainable supply of raw materials and the ensuing dedication to enhance innovation in this sector as well as the fact that innovation is key to survival for a European mining industry faced with difficult-to-access raw materials.

### 4.1. Uptake of innovations is problematic

Historically, the mining industry has been rather conservative when it comes to change. One of the key barriers to innovative mineral and metallurgical extraction and processing solutions is the hesitation of mining companies in adopting new solutions. This can be explained in part by **safety and risk** considerations.

Guaranteeing the safety of workers is a top priority for the mining industry. Therefore, before engaging into discussions for buying a product/solution, mining companies ask for a concrete example of another company that uses the product/solution successfully. Mining companies can as such be considered as fast followers, meaning that they take on board new developments only once they have observed that they work in other mining companies.

*Mining companies always say that it is a good business idea but each time they ask you to show them that it really works. First references are the do or die for a company.” –*

**Abillion Oy**

Consequently, a big challenge for companies developing solutions for the mining sector is the proof of concept which usually requires heavy investment.

According to Andrew Shook (General Manager of Surface Mining & Automation – Technology & Innovation at Rio Tinto)<sup>20</sup> “technological risk is something that the mining industry takes on very cautiously and only as absolutely necessary because it has got so much risk already in the ground and in the market. Proving something before it is deployed in the mine is actually a very wise thing to do and it makes a lot of sense.”

Market entry is even tougher if the company introduces a new and disruptive technology/solution for which the market

has to be created. As such convincing potential customers of the value of one's solution with few or no references to show for is a big challenge.

The industry's hesitations in adopting innovative solutions is especially a problem for small companies. Indeed, the latter often have trouble raising the necessary amount of awareness of their disruptive solution within the market and sometimes end up having to shelve a promising technology simply due to a lack of funds. Bo Malmberg, COO of Abillion Oy, for instance said that if you want to change people's perspective you need to have very good contacts and be present on every big seminar or trade fair and for participating in those events, you need a big wallet.

### 4.2. Market lacks proper communication and trust between relevant stakeholders

Clear communication is an important challenge to overcome for effective innovation. Communication is crucial amongst multiple stakeholders, from members of the company and the world of scientists to the policy makers at national and European level.

For a corporation, especially for mining companies that are traditionally rather conservative, it is extremely important that its employees understand the importance of innovation through transparency and dialogue, as well as they question the status-quo and are involved in the innovation process.

*“Trust is a global issue in the mining industry.” – KGHM Polska Miedź*

Agata Juzyk, Executive Director of R&D at KGHM Polska Miedź, noted that many miners are not in favour of automation as they are afraid that their jobs will disappear. Thus, involving them in the innovation process and informing them about the benefits of automation, such as decreased health and safety risks, is crucial. Furthermore, when testing an innovative product or solution in-situ, it is critical that the employees all collaborate and that there is mutual trust.

Secondly, proper communication is also important with the scientific community so that they know what mining companies really need in terms of innovative solutions. For instance, one of the interviewed companies said that it was difficult for them to get ready-made solutions instead of solutions they have to verify or further develop for years.



Finally, mining companies regret that open discussions with mining authorities are difficult. Although there is an increased political will to ensure security of supply of raw materials, political and public opposition can hinder the development of the industry.

Overall, mining companies need to invest in building trust with different stakeholders and explaining them what the benefits of innovation and the mining industry in general are.

### 4.3. Mining in Europe is becoming technically more demanding

Given that a majority of easy-to-access raw materials in Europe are depleted, mining companies have to dig deeper to extend the life of their assets. Exploiting deep deposits brings along new types of challenges and hazards, including

*“As we have to go deeper, the conditions underground are becoming increasingly difficult for our employees.” – KGHM Polska Miedź*

higher temperatures, rock stress and gas risks. Hence, working conditions become harder for miners.

In order to be able to operate in these harsh conditions, the mining companies have to innovate to optimise their processes. Faced with these challenges, mining companies like KGHM Polska Miedź are, for instance, developing processes to reduce the number of employees working near the face of the mine where working conditions are the most dangerous.

### 4.4. Energy and labour costs are higher in Europe

The mining sector is a highly energy intensive industry. Thus, energy prices have a significant impact on overall operating costs. Most mining sectors are fully integrated into global value chains where additional costs cannot be passed on to their customers. Therefore, mining requires competitively priced energy in order to benefit host communities over the long-term.<sup>19</sup> The International Energy Agency recently estimated that European industrial electricity prices were 20 per cent higher than in China and even at least double those in Russia and the US and for gas, European prices are three to four times those of the US, Russia and India and 12 per cent more than in China<sup>21</sup>.

Greater labour and energy costs compared to competitor countries entails higher production costs for the European mining industry. Automation and innovative solutions will lead to a more effective use of human resources and a reduction of energy consumption. This will enhance the European mining sector's competitiveness by offsetting higher unit costs by improved productivity with respect to these inputs.

## 4.5. Environmental regulations in Europe are stricter than in competing markets

Highly complex and often unevenly implemented and regulated legislative background within the EU-28 can discourage investment in the European mining and quarrying sector.

In the EU-28, there is a strong emphasis on social and environmental protection compared to competitor markets. This can be explained by the low public acceptance of mining and quarrying activities within the EU-28 as well as the fact that waste from extractive operations is one of the largest waste streams in the EU<sup>22</sup>. In the coming decades, the EU aims at becoming a low-carbon, energy-efficient economy.

Differences in mining costs in Europe and overseas are to a considerable degree linked to stricter environmental regulations, which force European mining companies to either buy emission allowances or heavily invest into the research and development of innovative solutions which allow decreasing their environmental footprint.

In January 2005 the EU Emissions Trading Scheme (EU ETS) was launched<sup>23</sup>, a core instrument for compliance with the Kyoto Protocol in the EU. The EU ETS is a cap and trade system aiming at reducing greenhouse gas emissions by factories. This scheme has significant impacts on the competitiveness of the European mining industry, including increased production costs due to the purchase of allowances and costs associated with CO<sub>2</sub> as a result of higher electricity prices and cost of burden of self-generation.<sup>3</sup>

Waste from extractive operations is one of the largest waste streams in the EU.<sup>22</sup> Some of these wastes are inert and do not represent a risk for the environment. Others however, may contain large quantities of dangerous substances that can pollute the environment, in particular media as water, soil, vegetation, and targets like the fauna and human.<sup>24</sup> Potential pollutant sources of the extraction and succeeding mineral processing include acidity and heavy metals. Remedial measures in these cases may be extremely difficult and costly. Hence, the advantage of preventive methods, like the innovations proposed in this trend.

TOMRA's sorters for instance are perfect for energy and water saving: energy costs and water stress are major drivers for the adoption of their sorters because they are based on dry separation and as the sorting is done on-site, it

<sup>3</sup> The EU ETS works on the 'cap and trade' principle. A 'cap', or limit, is set on the total amount of certain greenhouse gases that can be emitted by the factories, power plants and other installations in the system. The cap is reduced over time so that total emissions fall.



allows saving a lot of transport and energy costs down the stream.

#### 4.6. Lack of knowledge about mineral endowment and the sector

There is a lack of knowledge of mineral endowment in Europe which is due to a lack of investment in basic geological survey work. This absence of information on mineral endowment increases the risk of undertaking exploration activity, which, in turn, holds back the development of the EU's indigenous resources<sup>25</sup>. Furthermore, numerous companies developing solutions for the mining sector face general difficulties to get information on the mining industry, on what is being done and which specific solutions they need.

The COO of Abillion Oy, Bo Malmberg, for instance, said that as a small company, it was difficult for them to get access to information about the research that has been done and the people in different countries working on innovative solutions for the mining sector.

#### 4.7. Raw materials are vital for modern-day technologies

The minerals and mining industry is a key driver of the economy, occupying a crucial position at the start of the resource supply chain. The manufacturing of most modern-day products such as windmills (Figure 7) or batteries for electric cars for instance, needs high-quality raw materials. An estimated 30 million jobs in the EU depend on the availability of raw materials; as such, a sustainable supply of them has a clear and positive impact on Europe's industrial competitiveness<sup>1</sup>.

**Figure 7: Raw materials in a windmill**



Source: European Commission – DG GROWTH<sup>26</sup>

Although there seems to be a political will to ensure Europe's secure supply of raw materials, the mining industry globally considers that there is still a lack of social and political acceptance of the economic and social benefits of mining in the EU.<sup>26</sup> For instance, being granted operational permits or licenses is not easy without political and public support. This lack of public acceptance and awareness of the benefits of the mining industry can work to hinder the development of the extractive industries.

#### 4.8. Dedicated EU initiatives help drive innovation

European projects bringing together companies of the mining sector, such as the ones under the Horizon 2020 programme, are a driver for innovation in this sector.

Research and innovation that aims at securing the EU's competitiveness is done under the Horizon 2020 programme. Research directed at creating more efficient processes of raw materials is one of the objectives of the Raw Materials Initiative. KGHM Polska Miedź, for instance, is part of the European Innovation Partnership (EIP) on Raw Materials, which is the stakeholder platform that brings together EU countries, companies, researchers, and NGOs to promote innovation in the raw materials sector. The main goal of this partnership is to help raise industry's contribution to the EU's GDP to around 20 per cent by 2020 by securing its access to raw materials.<sup>27</sup>

The EIP's Strategic Implementation Plan sets out specific objectives and targets. Actions to achieve these include research and development, addressing policy framework conditions, disseminating best practices, gathering knowledge and fostering international cooperation.<sup>26</sup>

#### 4.9. Europe is at the forefront of the latest innovations

According to Euromines, the recognised representative of the European metals and minerals mining industry, EU companies are at the forefront of innovation in raw materials supply.<sup>25</sup>

Universities and research institutes play a vital role in supporting and sustaining innovative companies in the field. In fact, most interviewed companies benefit from close collaboration with research institutes and universities. This kind of bilateral cooperation has been recognised as critical success factor by the majority of the interviewed companies. Close ties to a specific research institute may serve a number of purposes, such as development and testing of solutions, mentoring and recruitment of talents.





## 5. Policy recommendations

Innovative mineral and metallurgical extraction and processing solutions are slowly making their way into the traditionally conservatively-minded mining companies. The analysis of drivers and obstacles above provokes several policy recommendations that could accelerate the development and the uptake of innovative solutions for the mining sector.

To unlock the large potential of innovative extraction and processing solutions, there is a need for an action at the EU level. Namely, it is recommended to create a European minerals and metals knowledge base, ease market entry and develop a common EU framework for the mining sector.

Most of the policy recommendations provided by the interviewed companies have already been proposed by the European Commission under the second pillar of the Raw Materials Initiative on the securing of the sustainable supply of raw materials from EU sources.<sup>28</sup>

### 5.1. Create a minerals and metals knowledge base within the EU

As previously mentioned, there has been a lack of investment in basic geological survey across Europe. The lack of knowledge of mineral endowment increases the risk of undertaking exploration activity with the cost that this entails and not finding any resources to harvest. That in turn holds back the development of the EU's resources.<sup>25</sup>

**Creating a public network of knowledge** would be beneficial for various stakeholders, including companies active in the extraction and processing, the regulatory bodies (governments and public authorities), stakeholders in academia and research as well as NGOs and the general public.<sup>29</sup> Information publicly made available should include data on mineral occurrences and deposits, economic and technical data on mineral exploration, extraction and processing, as well as data on the environmental and social dimensions of extraction.

As outlined in the Strategic Implementation Plan of the EIP on Raw Materials<sup>30</sup>, the establishment of a network of research, education and training centres as well as the **sharing of best practices** within the EU will have a positive impact on the development of disruptive solutions to the challenges of the European mining industry. These solutions would also contribute to a considerable increase in the competitiveness of the European mining industry.

### 5.2. Facilitate market entry through networking events

As mentioned in the section on drivers and obstacles, start-ups in this sector of the economy often signal the difficulty to raise market awareness and to find first customers that are willing to test their products. This is mainly due to the conservative outlook of the mining industry, resulting mainly from the safety and risk challenges it faces as well as the fact that mining is very capital-intensive.

**Networking events that allow smaller companies to present their innovative solutions to the giants of the mining industry could be a part of the solution.**

Companies developing innovative extraction and processing solutions would welcome opportunities to exchange, present their innovation and meet stakeholders in conferences and workshops. Many of such initiatives do take place, but small companies often do not have the funds to participate. In this sense, it would prove useful to organise networking events where small companies would be given the opportunity to present their innovative solutions to the giants of the industry. This would help them to raise funds and get their first references faster, and not shelve their viable solutions due to a lack of product awareness.

### 5.3. Develop a common EU framework for the mining sector

Currently, regulation and other policies pertaining to the supply of raw materials and minerals falls under the competence of individual EU countries jurisdiction. Hence, significant differences in regulation of the mining sector can be observed among the EU Member States.

Some countries do not yet have National Mineral Policies in place, others often have policies but not aligned with the other industrial policies. Hence, coherent National Mineral Policies should be developed that take into account the needs and the priorities of the country regarding this sector.<sup>29</sup>

The improvement of the raw materials framework, would foster a stable and competitive supply from EU sources and facilitate public acceptance whilst contributing to increased environmental protection.<sup>28</sup>



*"Mining regulations were introduced quite late in Europe, now they are not really adapted to the mining environment. Policymakers should work closer with the industry to understand the complexity of mining."* – **AGQ Mining & Bioenergy SL**

Furthermore, some companies signalled that the current mining regulations were often too complex and unrealistic. Hence, they asked for more **simplified and realistic mining regulation**. For instance, as Euromines also

However, while the companies asked for a **common EU framework**, they insisted on the fact that as geological and social conditions are not the same everywhere, some Member States require specific adaptation in order to improve access to raw materials for all.

emphasises, allocation of emission allowances under the ETS should be based on realistic benchmarks, technical standards and actual production.<sup>19</sup>

Furthermore, some companies say that the **extraction and processing of minerals and metals** in the European Union **should be further encouraged as a particular growth strategy**. By enabling the mining industry to grow in the EU, it will be possible to stimulate innovation in technologies and products that consolidate the EU's leadership in resource and energy efficiency.<sup>21</sup>





## 6. Appendix

### 6.1. Interviews

Company	Interviewee	Position
Abillion Oy	Bo Malmberg	COO
AGQ Mining & Bioenergy SL	Manuel José Garcia Gómez	CEO
KGHM Polska Miedź S.A.	Agata Juzyk	Executive Director of R&D
TOMRA Systems ASA	Stefan Ranstrand	President & CEO

### 6.2. Websites

Company	Web address
Abillion Oy	<a href="http://www.abillion.eu">www.abillion.eu</a>
AGQ Mining & Bioenergy SL	<a href="http://www.agqmining.com">www.agqmining.com</a>
KGHM Polska Miedź S.A.	<a href="http://www.kghm.com">www.kghm.com</a>
TOMRA Systems ASA	<a href="http://www.tomra.com">www.tomra.com</a>

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