ASSESSMENT OF SKILLS REQUIREMENTS AND AVAILABILITY IN THE MIREU REGIONS – Common report

Deliverable 3.2

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1. INTRODUCTION

The purpose of the report is an overview of the current and likely future specific skills requirements in a modern mining industry within Europe. This report is based on country reports for Finland, Greece, Poland, Portugal, Slovakia and Sweden. Report is limited to comparisons, summaries and conclusions. More comprehensive country reports can be found in attachments.

In order to capture the trend and to determine future needs, data from the last 15-17 years were planned to be analyzed (every five years: 2005, 2010, 2015 and the last year in which the data are available – 2016 or 2017). However, in the course of work on national reports, it turned out that it is difficult to collect unified data for all regions - countries. Information on educational and training opportunities has been presented in relation to mining and metallurgical operations of the regions. The education system and the structure of the government and self-government administration were also presented to better understand the conditions of individual countries and regions participating in the survey.

In this report the following information has been provided:

- Review of publications and reports in order to identify the future skill needs in mines around the world.
- Description of mining and metallurgy industry in regions as well as relation of those two industries in terms of resources and perspective.
- Academia potential in mining and metallurgy sector and its connection to industry.
- Training options at higher education level (BS, MS, PhD).
- Vocational education in mining and metallurgy in region and its connection to academia and industry.
- Training organized by mining and metallurgy industry.
- Skills requirements for regulatory and administrative bodies participating in permitting and supervision procedure.

The methodology was as follows:

- Obtaining public data from the statistical authorities.
- Obtaining information through questionnaires and telephone conversations.
- Analysis of official reports, documents as well as law and regulations.
- Analysis of papers and conference proceedings.
- Review of job advertisements.

Detailed methodology is described in each chapter.

1.1 Review of publications and reports

Since the beginning of the 18th century, people started using machines to perform their work (Fig. 1.1). Usually they applied various devices with a tasks which demanded force. Afterward people's focus was shifted into labor and the emergence of electricity. In 1969 the first programmable logic controller was invented, which was the base for the development of computerization process, slowly heading to automation process. Finally the digital transformation has brought numerous changes in the organizational process, methods of work and staff structure in companies (Vogel-Heuser and Hess,

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2016). Nowadays it has to be considered that every new technology changes the business models by providing new products and services. Work automation tools like robotic process automation (RPA) may lead to more productive businesses. Processes' activities are executed by virtual robots, element that guarantees the correctness of the performed activities.

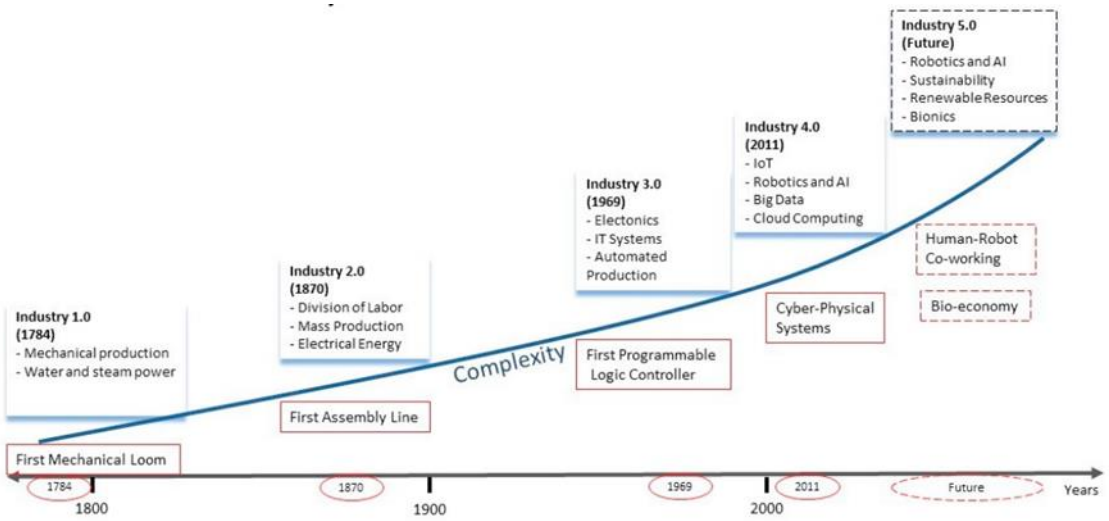

Fig. 1.1. The historical development of industrial revolution (Demir et al., 2019)

Macurova et al. (2017) pointed out that organizations transitioning to Industry 4.0 will be at risk of having workers who are not skilled at preparing, implementing, and using the new technologies, since higher educational institutions lag behind in developing adequate educational programmes, both formal and informal. In the same time, Weber (2016) stated that Industry 4.0 could have a short-term negative impact on the decreased demand for the low-skilled workers. Future challenge will be restructuring the jobs and educational programs simultaneously (Kane et al., 2015). Therefore, it is crucial for manufacturing organizations, not only to prepare for the restructuring of their production processes (Ivanov et al., 2016), but also to analyze prevalent job profiles, in order to determine the required employee competencies (Pejic-Bach et al., 2020).

Pejic-Bach et al. (2020) stated that taking into consideration the importance of Industry 4.0., a deep insight into the required knowledge and skills has to be done. Further, since these changes in job characteristics are rapid, fast tool for analysis of job advertisements is needed (Hecklau et al., 2016, Pinzone et al. 2017).

This development will challenge the global companies as well as workers. K. Shwab, the founder and executive chairman of the World Economic Forum states that "the inherent opportunities for economic prosperity, social progress and individual flourishing in this new world of work are enormous, yet depend crucially on the ability of all concerned stakeholders to instigate reform in education and training systems, labor market policies, business approaches to developing skills, employment arrangements and existing social contracts" (Deloitte, 2018). Beside Industry 4.0., mining industry is going to be challenged by the *mine-of-the future concept*. Some key milestones of those two concepts are similar, like the role of automation of the processes and the necessity of new skills and requirements.

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Job advertisements are a relevant source of information about the required skills and knowledge, which can be used in order to provide fast insight into the changes in job profiles. The direct job offer profile was one of the analyzed method which was made for these report. Further, various papers and reports were studied in order to identify future skills which may be needed by all workers in mining and metallurgy industry. These new set of skills will be helpful in defining the current and future challenges of the industry. In general the potential new technologies, which include e.g. automation and algorithms, will likely create new high-quality jobs as well as vastly improve the quality and productivity of the existing work. On the other hand, the technical advancement may also reduce the number of workers needed. The *Future of Job Report* claims that to prevent a lose-lose scenario, technological change accompanied by talent shortages, mass unemployment and growing inequality, it is critical that business take an active role in supporting their existing workforces throughout reskilling and upskilling, as well as the governments which should support these efforts (Deloitte, 2018).

Oshokoya and Tetteh (2018) identified problems of both African as well as worldwide mining industry. They indicated that mining industry continues to be a major source of employment despite the challenges faced by mining engineers or graduates. The biggest concern in terms of the future mining is the issue of skills shortage. Although the industry has undergone several changes in terms of technological advancements, it is further envisioned that the future-mine will rely on a highly skilled labor force with the ability to perform several tasks through automated and remote-controlled operations and monitoring. Moreover it is predicted that mining industry is expected to be knowledge-driven through a database model that receives and sends information (environmental, mining production and mineral processing) to enable proactive decisions to be made from both operational and control room perspectives. By taking all above statements into consideration the identification of current and future challenges as well as skills and requirements of mining and metallurgy industry has to be made. The four main key focus areas of the future-mine have been identified as (Oshokoya and Tetteh, 2018):

- Operating practices and technology.
- Talent and leadership.
- Partnership with key stakeholders.
- Governance.

Guerico et al. (2009) predicted that the main challenges of future mining will be related to:

- The depth of the deposits (deposits are getting deeper).
- Low grade of raw material.
- Higher energy coast.
- Increased environmental limitation.

Often observed protests against new mines show the lack of social acceptance for mining activities and an increase in the level of democracy. Another challenge for the mining companies and governments will be increasing social awareness of the importance of minerals for the economy (for example through the education). Oshokoya and Tetteh (2018) concludes that mining industry requires the adoption of the right talented and skilled labor force. This therefore requires education to include

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twenty first century mining engineering skills, which will allow to possess all skills and requirements to solve various problems from all four above mentioned key areas. Education is important also for increasing the knowledge of regulatory and administrative body involved in permitting procedures as well as for increasing awareness of local people. Moreover, Oshokoya and Tetteh (2018) stressed that the development and utilization of various advanced technologies are essential in future-mine. On the other hand the shortage of skill in the mining industry is known worldwide, and several mining stakeholders (mining engineering universities, government, mining professional bodies, etc.) have tried to address this issue.

Since past 10 years mining and metallurgy industry have changed. New technologies, standards and requirements have challenged the industry. All companies have understood that in order to achieve success and maintained the value chain, they have to evolve, and they have to outwork new best practices. Soon there will be a shift towards Industrial Revolution 5.0. It has to be mentioned that industrial revolutions have mostly been replacing man work with machine work (Demir et al., 2019). Next revolution will likely be human-robot coworking. Moreover, Demir et al. (2019) stated that either we call it a “machine” or a “robot”, these machines will eventually take responsibility for most of the jobs that are hard, boring, or dangerous for people. The speed of increased automation in our daily lives is largely dependent on the technology level and the acceptance of robots by people. At this point, we cannot be sure what the theme of Industry 5.0 will be, but we can be sure that human-robot coworking will be a significant innovation for society and it will significantly affect the way we conduct businesses.

What we are certain is that all challenges and issues mentioned above, as well as, adoption of new transformative strategies will depend on a new set of skills and requirements. With approaching new technological development we can predict what type of skills will be needed.

2. MINING AND METALLURGY INDUSTRY IN MIREU REGIONS

The following MIREU regions were analysed: Alentejo in Portugal, Košice in Slovakia, Lower Silesia in Poland, Lapland in Finland, Sterea Ellada in Greece as well as Norrbotten and Västerbotten in Sweden. Regions covered by the project are diversified in terms of type of the industry, nature, landscape and culture. Almost all described regions are rich in various types of mineral deposits – energy, metals, industrial and chemical minerals etc. Expect mineral deposits some of the regions like Sterea Ellada, and Alentejo are best known as tourist destinations, or have strong mining heritage such as Lower Silesia and Košice. This report is a summary of all country reports and more detailed, regional information can be found in the country reports (Appendixes 1-6).

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2.1 Alentejo region, Portugal

The Alentejo region (NUTS II) is located in the south-central part of the Portugal. It includes districts: Portalegre, Évora, Beja, Setúbal (only southern half) and a part of Santarém. It is strong mining region with a great mining heritage.

In Alentejo, there are considerable reserves of metallic minerals. There is a clear dominance of copper, manganese and iron in number of occurrences/deposits. According to the (CCDR 2014) the biggest deposits in Alentejo Region are of copper and zinc which are located in Aljustrel and Castro Verde municipality. Ornamental rocks (marble, granite and schist), aggregates and metallic minerals (especially pyrite deposits around Baixo Alentejo) also occur in the region (CCDR 2014). The mineral deposits and active mines in Alentejo region are presented in the Fig. 2.1.

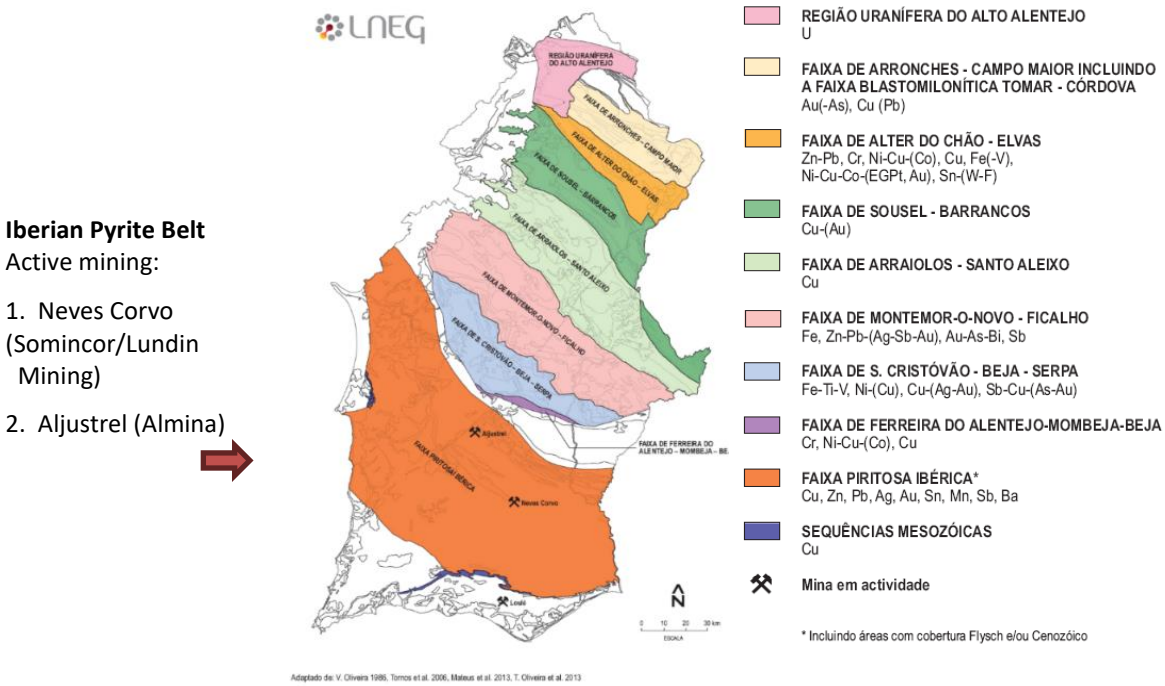

Fig. 2.1. Metal and mineral deposits in the south of Portugal (NOVA Country Report, 2019 – Appendix 1)

Metal production is being carried out in three locations from two of which are set up in Alentejo region and the third one is in the Centro region. The Alentejo (Cu, Pb, Zn) and Aljustrel mining sites is being operated by Almina company and Neves-Corvo (Cu, Zn, Pb, Ag) is being operated by Lundin Mining Corporation. The current copper and zinc mineral reserve estimates at Neves-Corvo will support a life estimated of mine of over thirteen years, to 2030 (Lundin Mining, 2018)

Since 2009 the mineral output has been dropping down both in Portugal and in Alentejo Region. On the other hand the production value increased. All detailed information on Alentejo region is provided in Appendix 1.

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2.2 Košice region, Slovakia

Košice region is located on the southern part of Slovakia and may be characterized by a strong mining heritage. The mining activity was focused on metallic ores: such as iron, copper gold and silver. Various mineral deposits such as metallic (iron, copper, silver, gold and mercury), chemical (rock salt, barite), industrial (e.g. dimension and crushed stones, magnesite, talc, sand and gravel and limestone), energy (natural gas and uranium), gemstones (precious opal) and thermal water wells were identified (Fig. 2.2.) However, the vast majority of deposits are currently considered as not economically suitable for exploitation.

In Košice region several areas (raw material deposits) have been registered to the exploitation to various companies. The main part of Eastern Slovakian basin, rich with a natural gas and gasoline is being registered to NAFTA a.s. company. In the Košice part of Slovak Ore Mountains four exploitation areas of metallic raw materials and two deposits of rare earth elements have been defined. Five geothermal/hydrothermal exploitation areas were given to various exploitation companies in Košice region. In Zemplín Mountains two exploitation areas to the exploitation of precious/metallic raw materials have been defined. Uranium deposits (Novoveská Huta and Košice-Jahodná) have been also located in the region. The exploitation of Košice-Jahodná deposit has been terminated after the strong public opposition in 2015. More detailed information on Košice region is provided in Appendix 2.

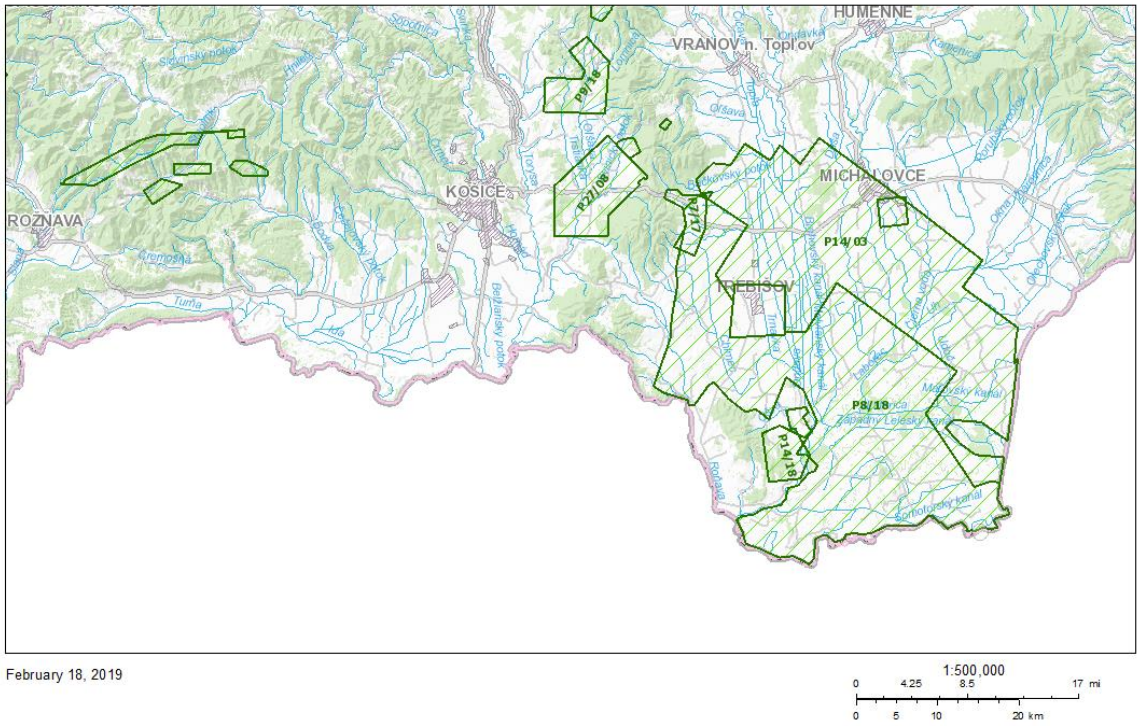

Fig. 2.2. Metal and mineral deposits in the Košice region (TUKE Country Report, 2019 - Appendix 2)

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2.3 Lapland region, Finland

Lapland is the largest but the least populated region of Finland. Yearly export of Lapland is being estimated ca. 7.0 % of Finland's total export. Lapland's economy is based mainly on mining, metallurgy and steel industry. Industries like forestry, agriculture and tourism also take a big role in Lapland's economy. The mineral resources of Lapland's region include Au, Ni, Cu, PGM, Cr, industrial minerals, Li, Fe, Nb, Ti and gemstones (Fig. 2.3). There are three operating metal mines in Lapland, including the largest operating gold mine of EU (Kittilä municipality) and the only operating chromium mine in EU (Kemi mine). The third mine Kevitsa extracts Ni, Cu, Au, Pt and Pa. The total production of the mines are Kittilä 1.564 Mt, Kemi 1.93 Mt and Kevitsa 7.7 Mt. (Viinamäki et al., 2015)

The general outlook of Lapland's mining industry is positive. This can be observed from the number of the exploration permits which are/were granted as well as by ongoing development projects (Uusipaavalniemi et al., 2018; TEM, 2018).

The Sakatti (Cu, Ni, PGM), Hannuvaara (Fe), Pahtavaara (Au), Suhanko (PGM, Ni, Cu, Au) and Sokli (apatite) mine development projects are already at permit application stage. The Sakatti located in Sodankylä is the new mining project. Its proven resources are 121 000 tons of copper, 87 000 tons of nickel and estimated resources 724000 tons of copper and 337 000 tons of nickel. The idea of Hannukainen project is to re-open of an old iron mine. The ore reserve is being estimated of ca. 136 million tons, and the annual productions is being expected of ca. 2 million tons for iron concentrate and 40 000 tons for gold-copper concentrate. Its planning and permitting processes will last until 2020. Suhanko ore resources are estimated of ca. 208.5 million tons. The Sokli deposit represents one of the largest phosphate reserves in Finland, but the operator Yara Finland Ltd decided to halt the development of the project due to the anticipated profitability of the project. However, the company decided to continue the environmental and water permit application that were approved in 2018 (Viinamäki et al., 2015). Pahtavaara mine operated between 1996 and 2014 with daily mill capacity of 1,400 tons and total gold production 10.76 tons. In 2016 Rupert Resources Ltd. acquired exploration permits and concession. Up to now the company is being developing the mine re-open project. Nowadays the most promising ongoing exploration project in Lapland is the Rompas-Paloka's gold and uranium project. The most recent drill program was completed in April 2018 with a total of 75 drill holes completed for a total of 16.214 metres. A major re-assay program to determine cobalt grades associated with the disseminated gold mineralization proved highly successful with Au grades improving the continuity and thickness of the mineralized intervals, with some Au examples doubling the grade-width of the originally reported gold intersections. All detailed information on Lapland region is provided in Appendix 3.

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Fig. 2.3. Metal Ore and Industrial Minerals Mines, Mine projects and closed mines in the region of Lapland

2.4 Lower Silesia region, Poland

The Lower Silesian Voivodship is located in the south-west part of Poland. It is one of the most diversified regions of Poland in terms of nature, landscape and culture as well as probably the most industrialized region with a long mining tradition and big mining heritage.

The Lower Silesia region's deposits consists minerals from each group: metallic (copper and accompanying elements: silver, nickel, zinc, cobalt, molybdenum, lead, vanadium), chemical (rock salt, barite, fluorspar and sulfur as an accompanying mineral), industrial (e.g. dimension and crushed stones, backfilling sand, sand and gravel, glass raw materials), energy (brown coal, natural gas) as well as brines, curative and thermal waters. Some of the minerals like: copper ore, silver, nickel, gold, whiteware ceramic clays, quartz veins, magnesites, quartz rocks and kaolin are unique on a national scale. Location of main deposits are presented in the Fig. 2.4.

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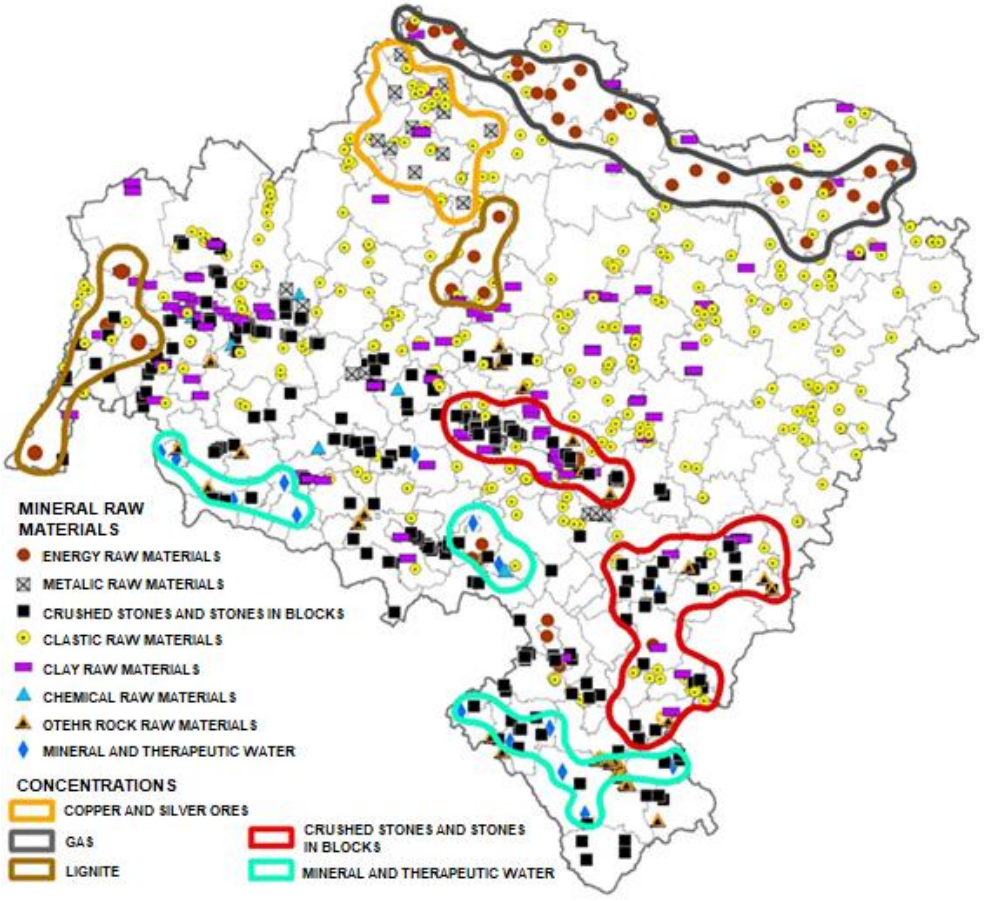

Fig. 2.4. Metal and mineral deposits in the Lower Silesia region (AGH-UST Country Report, 2019 – Appendix 4)

Major gross of the region's economy comes from the exploitation by The KGHM Polska Miedź S.A of the copper and silver ore in the Legnica-Głogów Copper District. Copper deposits in the region are exploited in three underground mines: "Lubin", "Polkowice-Sieroszowice" and "Rudna". The extracted material is enriched in the Concentrator Plant, while the production of copper, silver, gold, lead and other metals takes place in smelters: "Głogów", "Legnica" and "Cedynia". All plants belongs to KGHM Polska Miedź S.A. (KGHM S.A.).

Latest research shows a large volume of prognostic, prospective and hypothetical resources in SW Poland (outside the Lubin-Sieroszowice Copper District). Prognostic resources can be found in the areas adjacent to the existing mines of Lubin-Sieroszowice copper district (Białołęka, Grochowice, Kulów, Luboszyce). Potential deposits in Nowiny, Żarków and Mirków area are easy accessible on depth range of ca. 400-600 m, 1000-1500 m and 1100-1300 m. Sulmierzyce and Janowo areas have considerable resources and reasonable depth (1600-1900 m), and Mozów area (2100-2700 m) is a high potential deposit because of the Cu-Ag high grade mineralized body with a possible continuation to south east through Jany and Grochowice prospects (resource depth 2000-2200 m, 1600-1700 m) towards the Lubin-Sieroszowice mining district. Approximately 179 million tons Cu and 346 thousand tons Ag concentrated are estimated as potential resources in prospects of SW Poland for future mining. This will be possible, when geological, technological and economical barriers (depth,

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temperature, oil and gas) will be overcome (Oszczepalski et al., 2016). All detailed information on Lower-Silesia region is provided in Appendix 4.

2.5 Sterea Ellada region, Greece

Region of the Sterea Ellada is located in the central part of the Greece. It is one of the strongest mining region with a huge mining heritage. Sterea Ellada region is rich with a metallic and industrial minerals such as magnesite, ferronickel, bauxite, dolomite, marble, decorative stones and chromite (Fig. 2.5). The bauxite deposits have been identified as the largest deposits in Europe. Marble and chromite deposits have been considered as not sufficient utilized (Konsolas et al., 2012).

Beside mining sites mineral processing plants may be found. Some of the large companies which operate in the regions are: Aluminium of Greece (AoG) which specializes in mining and primary aluminium production as well as red mud (aluminium mining waste) valorisation into marketable products and Larco Nickel Mining which is one the biggest nickel production company in Europe (Aluminium of Greece; LARCO GMMSA). The presence of Terna Magnesite S.A. (TERNA MAG, the GEK Terna) a world-class magnesite and magnesia producer in the northern part of Euboea island and Heracles General Cement Company (Heracles GCCo), one of the most important cement Greece's producer, also play a critical role in region's economy. Finally, another company of great importance in the region of Sterea Ellada and specifically in the peripheral unit of Viotia is TITAN S.A. which produce significant quantities of cement. All detailed information on Sterea Ellada region is provided in Appendix 5.

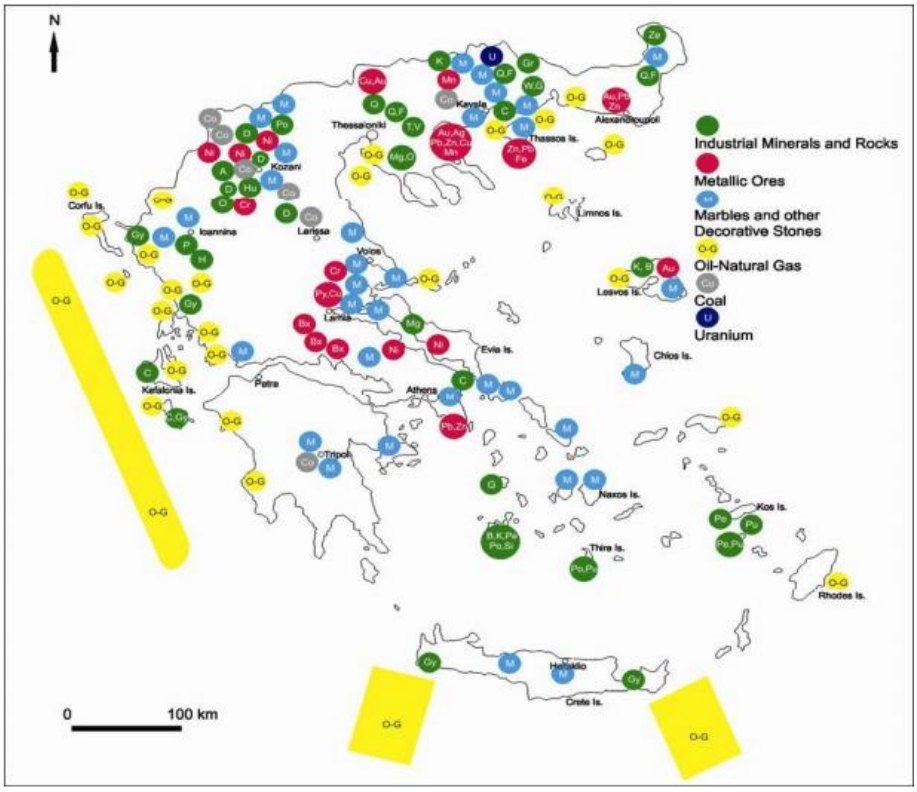

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Fig. 2.5. Metal and mineral deposits in the Sterea Ellada region and in Greece (NTUA Country Report, 2019 – Appendix 5)

2.6 Norrbotten and Västerbotten regions, Sweden

Sweden is a dominant mining country, especially in the iron ore market where the state-owned company LKAB supplies over 90% of total iron ore production in the European Union (Geological Survey of Sweden, 2016). The importance of mining is also reflected in Swedish exports. The mining industry, including steel, represents about 10% of the country's gross exports and about 60% of the net exports (Vasco Advisers, 2014). Figure 2.6. shows natural resources deposits in Sweden.

Since the beginning of the 1980s, mine production in the country has increased substantially. Still, at the same time staff requirements have become significantly lower due to investments in productivity improvements. In 2016, there were 12 active mines in northern Sweden, six in the county of Norrbotten and six in the county of Västerbotten. Norrbotten accounts for over 83% of the export value of mining, and of the total exports from this county 64% are mineral products. The dominant part of this can be attributed to iron ore. All detailed information on Västerbotten and Norrbotten regions are provided in Appendix 6.

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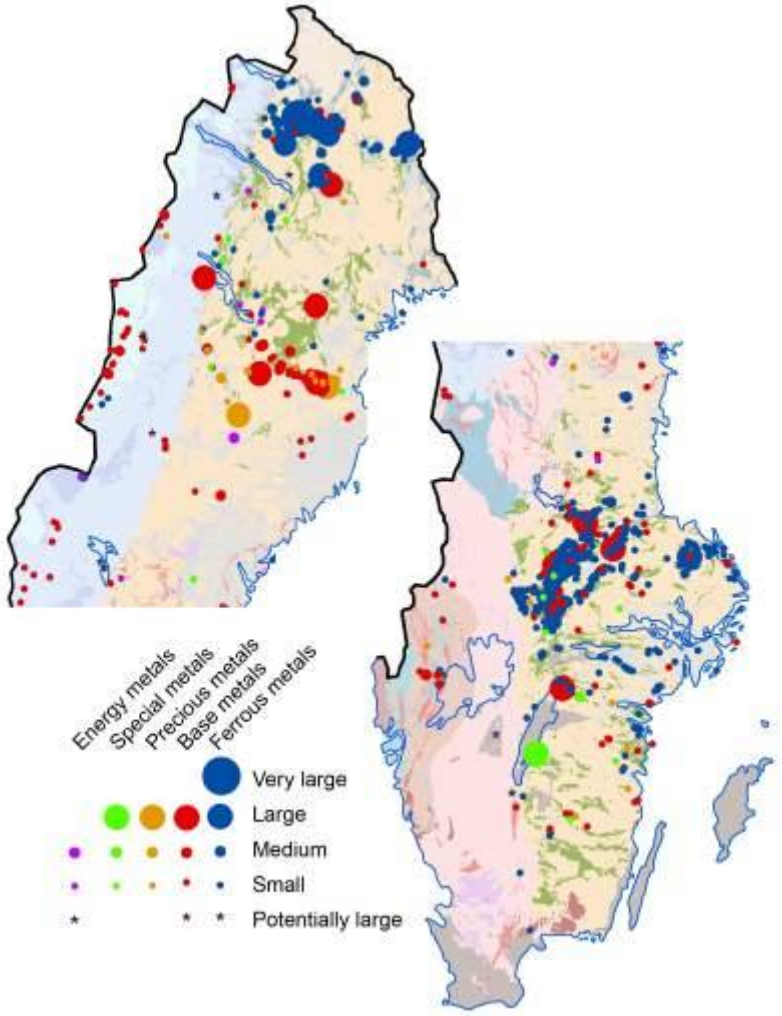

Fig. 2.6. Occurrence of natural resources in Sweden (LTU Country Report, 2019 – Appendix 6)

2.7 Conclusions

According to detailed country reports it can be concluded that:

- All regions have long mining tradition as well as strong mining heritage. Moreover some regions like Sterea Ellada and Alentejo are additionally tourist destinations. Especially in case of the Alentejo region some of the old mining sites were revitalised and they have become touristic attractions. In such cases the additional synergies between old mining industry and nowadays tourists industry may be found.
- In all described regions there is a presence of almost all types of mineral and metal deposits. It should be emphasized that the biggest mines or deposits of gold, copper and bauxite within EU can be found,in regions of Lapland, Lower Silesia, and Sterea Ellada, respectively.
- In the past 10 years the turnover of mining and metallurgy production has increased (e.g. Lapland, Lower Silesia), or remained same level (e.g. Alentejo, Košice, Sterea Ellada).

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- Mining and metallurgy companies in each region are looking for solutions and technologies that in one hand will contribute to lowering production costs, and on the other hand will allow for higher recovery rates of minerals. The whole industry, and especially the new mines are strongly subjected to the *Fourth Industrial Revolution* in which digitalization and automation of the processes are in key role.
- The social acceptance towards mining activities in each individual regions is usually higher than elsewhere in the country. This may be explained by the better regional social awareness of mining and metallurgy industry and its impact on the regional economy. In order to improve the acceptance of the mining activity as well as the future of potential investments, the social acceptance in each country has to be improved.
- Almost in all regions areas with a high mining potential for future investment can be found. In Lapland region some of the permissions and concessions for mineral exploitation (Ni, Fe, Au, apatite, phosphate) has been drafted. In other regions like Lower Silesia (Cu), Aletejo (Cu, Zn) and Košice (metal deposits) existing deposits have been consider as a high potential but only when geological, technological and economical barriers (depth, temperature, oil and gas) will be overcome.
- Mining and metallurgy sites are usually located in the most rural and secluded areas (e.g. Lapland, and Aletejo regions) what implies that in the macro scale these companies are becoming the most important employers and because of that all socio-economic effects have to be considered.

3. NATIONAL AND INTERNATIONAL BASE FOR ACQUIRING SKILLS

3.1 Introduction and methodology

The methodology of collecting data for this chapter base on:

- Data from career research.
- Public data from the statistics authorities (Statistics Poland, ELSTAT, Hellenic Federation of Enterprises – SEV, OECD).
- Questionnaires and phone calls with representatives of industry and vocational schools.
- Analysis of official reports.

An important source for the professional situation of people who have finished their education in universities and vocational schools is graduate career research. Unfortunately, a very small number of institutions provide such statistics. For example Lower Silesia does not conduct graduates career monitoring, due to staff shortages and lack of funds. Every fifth school admits that there is a lack of knowledge about methods on this kind of research or there is no such obligation (Analiza potrzeb szkół, 2016). Therefore, AGH-UST conducted a survey among over than 250 vocational schools that offer education connected with mining and metallurgy, but response rate

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was very poor. Only seven questionnaires were send back. Also direct calls were not effective. AGH-UST took another attempt to obtain needed information from vocational schools. Two short questions about the number of graduates working in the profession and cooperation with the industry were sent to schools via e-mail. Again, there was no response. On the basis of phone calls, it is known that most of the schools do not collect data about their graduates.

Education systems in MIREU regions are usually based on regulations adopted by national ministries, which are responsible for basic and higher education. Education systems do not differ significantly between the EU member states. All of them consist of public and private primary schools, lower secondary schools and upper secondary schools (general and vocational) (Fig. 3.1). Differences can be seen in the period of compulsory education. In each country it is possible to study and graduate at a bachelor, master and doctoral level. Most of the regions offer possibility to study at the university without tuition (for EU citizens), except Portugal. Table 3.1 shows the details of educational system in each studied regions.

Table 3.1. General information about educational systems in MIREU countries *source: own work*

Country	Basic education controlling authority	Higher education controlling authority	Age of compulsory education	Cost of higher education for EU countries
Poland	Ministry of National Education	Ministry of Science and Higher Education	7-18	Free
Greece	Ministry of Education, Research and Religious Affairs	Ministry of Education, Research and Religious Affairs	6-15	Free
Portugal	The Education Ministry	Science, Technology and Higher Education Ministry	6-18	Paid
Sweden	The Ministry of Education and Research	The Ministry of Education and Research; Swedish Higher Education Authority; Swedish Council for Higher Education	6-15	Free
Slovakia	Ministry of Education of the Slovak Republic	Ministry of Education of the Slovak Republic	6-15	Free
Finland	Ministry of Education and Culture	Ministry of Education and Culture	6-15	Free

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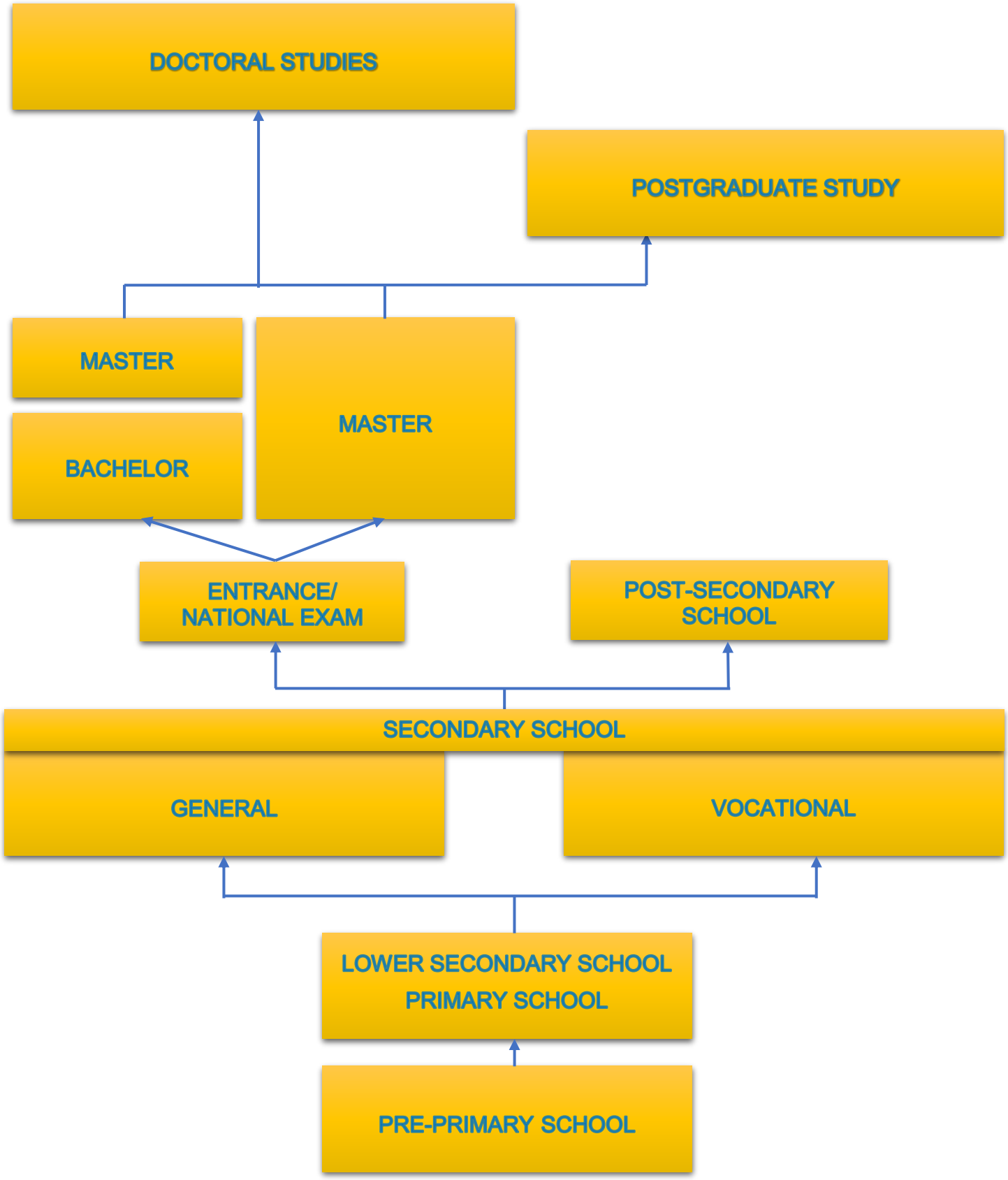

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Fig. 3.1. General education system in MIREU Regions
source: own work

3.2 Identification of academia potential in mining and metallurgy sector and its connection to industry

The higher education system is compatible within Europe through the Bologna Process in which degrees are divided into 3 cycles: basic level, advanced level and doctoral level. Universities are state, self-government or private organizational units of higher education and research. They are schools that educate high school and technical graduates who have passed the national final examination (exams names vary depending on the country) or university entrance exams. First level of studies end with the awarding of a bachelor's or an engineer's degree, and a second level end with the awarding of a master's degree or a master's degree in engineering (in some of the countries). Completing a second level allows to apply for doctoral studies. In Poland, some universities also offer postgraduate studies. Table 3.2 shows the number of institutions, faculties and fields of study directly and indirectly related to mining and metallurgy. Detailed lists of fields of study can be found in the regional reports (Appendixes 1-6). Fig.

Table 3.2. *Number of institutions, faculties and field of study related to mining and metallurgy in selected EU countries.* source: own work

Country	Number of institutions	Number of faculties/ departments	Number of fields of study directly connected to mining an metallurgy*	Number of fields of study indirectly related to mining and metallurgy
Poland	15	27	13	58
Greece	10	34	5	37
Portugal	6	8	3	20
Sweden	1	1	3	9
Slovakia	3	4	2	21
Finland	14		8	32

* such as mining engineering, mining technology, metallurgy, exploration etc.

3.3 EUR-ACE® labelled programs and certification

To increase the opportunities of graduates finding a job on labor market the universities' authority apply for the EUR-ACE® label. EUR-ACEÂ® label is a type of accreditation created by the European Network for Engineering Accreditation (ENAEE), which brings together many European organizations involved in training engineers. One of the main activities of the ENAEE network is the EUR-ACE accreditation program European Accredited Engineer label which involves granting a certificate to engineering degree programmes thus confirming their high quality as well as compliance with accepted European standards and principles. The accreditation system is closely linked with the Bologna process, and is based on the Standards and Guidelines for Quality Assurance, which is the key text on the subject of quality and accreditation. Awarding EUR-ACE® label is predict by audit make by national authorised agencies (table 3.4). Graduates of faculties that have obtained a certificate

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EUR-ACEÂ® Label can apply a job in the EU. Presented list include only three programmes related to mining and geology and one to metallurgy, while the others relate to specific issues such as mechanics, robotics, electrical and environmental engineering.

Table 3.3. *Information about EUR-ACE® label and national Authorised agencies in researched countries.* source: own work

Country	Authorised agencies	Total number of programmes	University / programme related to mining and metallurgy that awarded EUR-ACE® label
Portugal	OE - Ordem dos Engenheiros	71	**Porto University / Mining and Geo-environmental Engineering**; Environmental Engineering; Mechanical Engineering; **Metallurgical and Materials Engineering** School of Engineering – Polytechnic of Porto / Geotechnical and Geo-Environmental Engineering; Mechanical Engineering Technology and Management School / Mech anical Engineering; Electrical Engineering **New University of Lisbon / Geological Engineering**; Environmental Engineering; Mechanical Engineering Aveiro University / Electronic Engineering and Telecomunications; Environmental Engineering
Slovakia	ZSVTS – Zväz slovenských vedeckotechnických spoločností	13	Technical University of Kosice / Mechanical Engineering
Finland	FINEEC – Korkeakoulujen arviointineuvosto KKA	25	Lappeenranta-Lahti University of Technology / Sustainable Production in Mechanical Engineering JAMK University of Applied Sciences / Information and Communications Technology; Logistics Engineering Savonia University of Applied Sciences / Mechanical Engineering Saimaa University of Applied Sciences / Mechanical Engineering and Production Technology Tampere University of Applied Sciences / Environmental Engineering
Poland	KAUT – Komisja Akredytacyjna Uczelni Technicznych	130	**AGH University of Science and Technology / Mining Engineering and Geology** Silesian University of Technology / Applied Mechanics and Machine Design; Automatic Control and Robotics, Electronics and Telecommunication, Informatics; Electrical Engineering Opole University of Technology / Environmental Engineering Wroclaw University of Technology / Electrical Engineering Warsaw University of Technology / Materials Science and Engineering; Automatics and Robotics; Environmental Engineering Military University of Technology / Mechanical Engineering; Mechatronics Bialystok Technical University / Automatic Control and Robotics; Electrical Engineering; Mechanical Engineering; Lublin University of Technology / Electrical Engineering Gdansk University of Technology / Electrical Engineering; Mechanical Engineering University of Technology and Life Science / Electrical Engineering

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			Nicolaus Copernicus University in Torun / Automation and Robotics Lodz University of Technology / Automatic Control and Robotics
Greece		1	University of Patras/none
Sweden		0	--

3.4 Number of students and graduates

In the MIREU countries, similarities in the level of education can be observed. Since 2010, the percentage of people with only basic education is constantly decreasing (Fig. 3.3). The percentage of people with secondary education remains more or less at the same level (**Error! Reference source not found.**), but the percentage of people with higher education is constantly growing (**Error! Reference source not found.**). Considering the fact that the number of students at higher education institutions is decreasing every year, it can be concluded that the reduction in number of students is not the result of a lack of interest in higher education, but a consequence of the demographic decline. The same situation can be observed in mining and metallurgy related fields of study in Poland and Slovakia. In Greece, the number of students at engineering departments (e.g. civil, mechanical, electrical engineering) is decreasing, however there is a growing interest in studying in fields related to the environment (e.g. environmental engineering, geology). The opposite situation is observed in Poland, where students (as well as employers) favour increasingly engineering professions related to machine operation and automation. Some vacancies available in the first cycle of the Portuguese Public Universities/Faculties offering geology and mining have been reduced (three institutions), but courses on geological engineering and geological and mining engineering maintained their vacancies. Based on the available statistics, the lower degree graduates in Finland has been rather constant between 2014 and 2017, excluding a peak in basic vocational degrees in 2014. In contrast, the higher level degrees in minerals processing has increased steadily since 2014. In geosciences, the amount of graduates has been steady excluding the bachelor's degree which has decreased since 2014. However, most of the university students in Finland complete master's degree, as it is commonly the requirement of the employers and the deviation between BSc and MSc degrees might indicate e.g. geosciences being either a minor subject and thus completed only at BSc level.

European countries have different approaches to collecting data on students and graduates of particular majors. It is easy to find information on the number of students and available vacancies for particular fields of study, but there is a lack of information on the number of graduates. Data is rarely published online or is not available at all. The reason may be the relatively low rate of graduation in most countries, which do not exceed 50% (except Finland, Lithuania, Spain, Denmark and Slovenia) (Fig. 3.6.). Furthermore, a comprehensive statistics of all graduates cannot often be given since many mine workers are trained and educated either through apprentice and on-job learning or are graduated from other fields of e.g. chemical engineering and are therefore not included in the statistics.

As in the case of education at the national level, a decline in the number of students in vocational schools induced by demographic decline is also observed in the regions. According to Eurostat, in the EU, 3.3 % of students in lower secondary education

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followed vocational programmes in 2016, with this share reaching 49.3 % for upper secondary education and 91.5 % for post-secondary non-tertiary education.

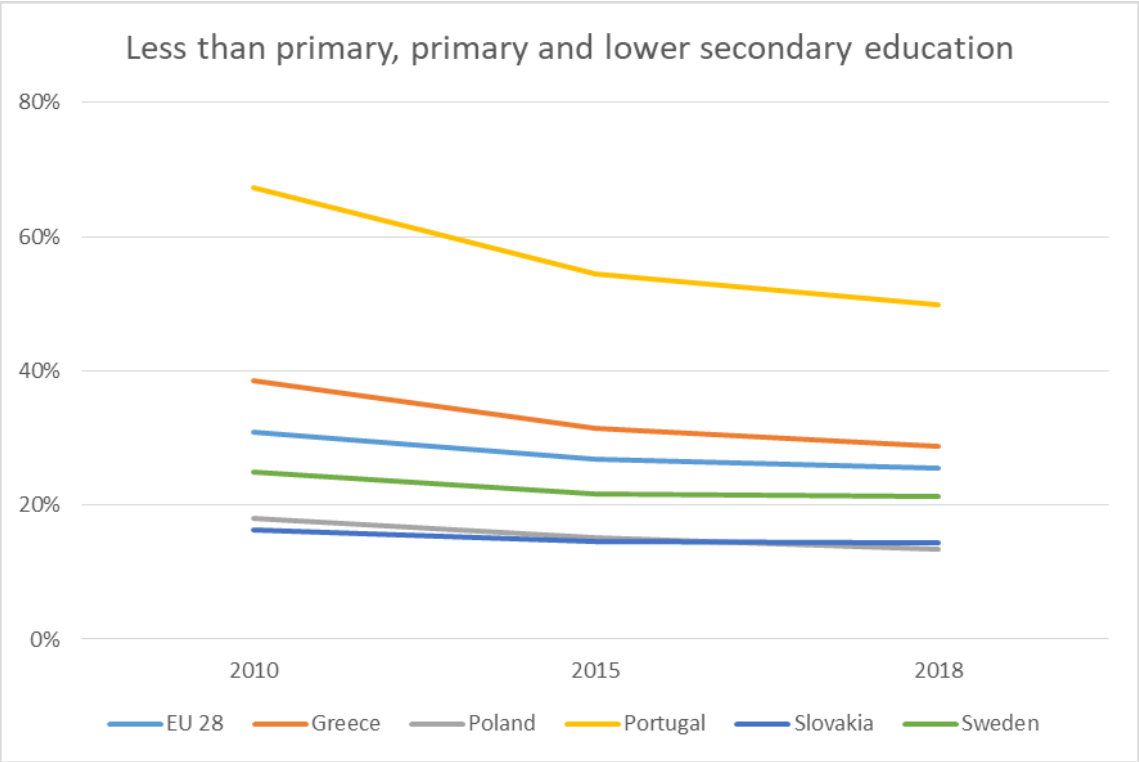

Fig. 3.3. Percentage of people with less than primary and lower secondary education, source: own work, OECD

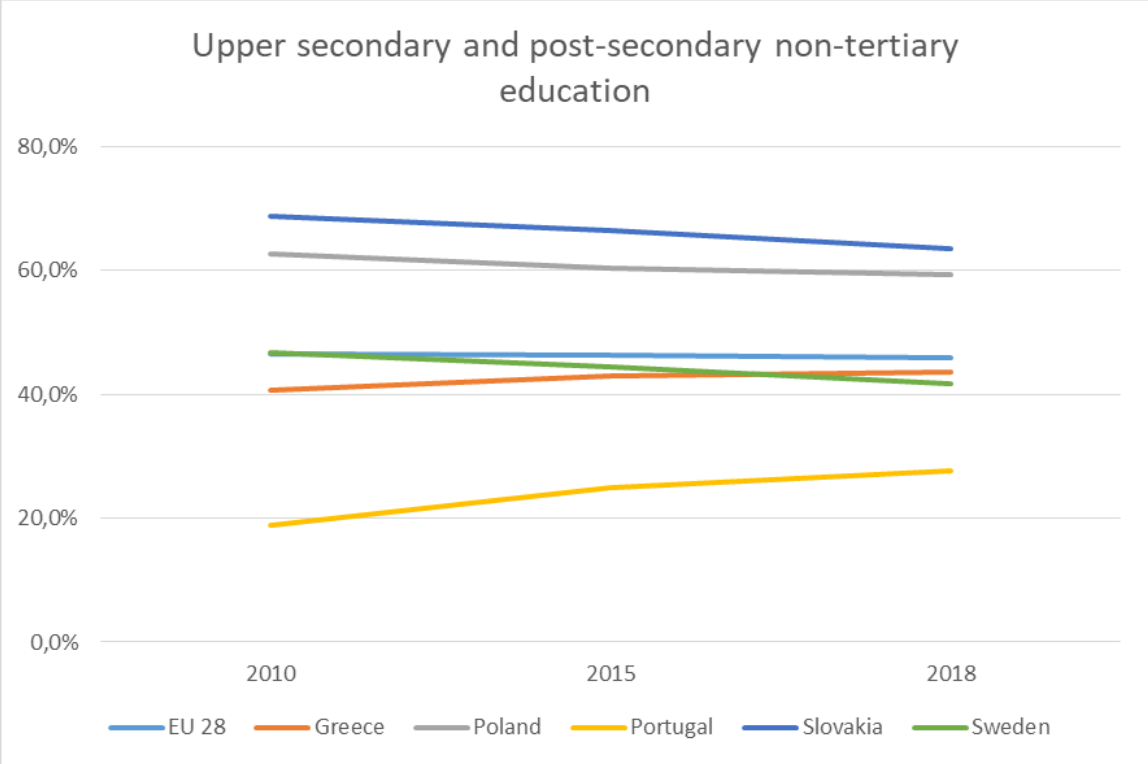

Fig. 3.4. Percentage of people with upper secondary and post-secondary education, source: own work, OECD

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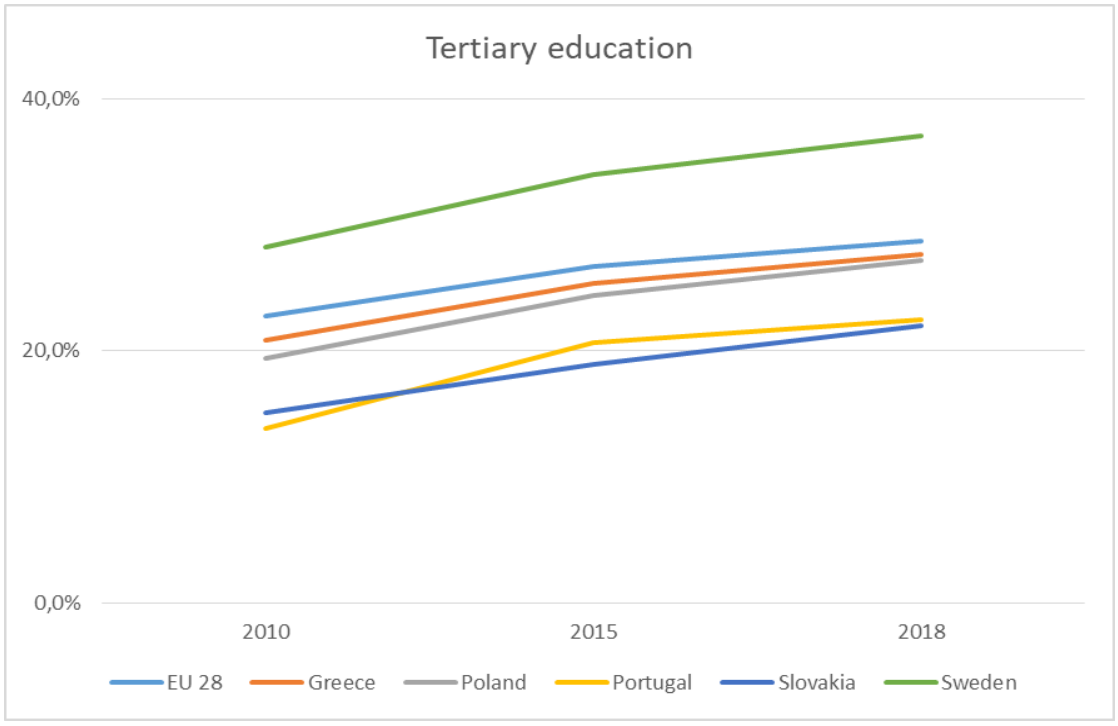
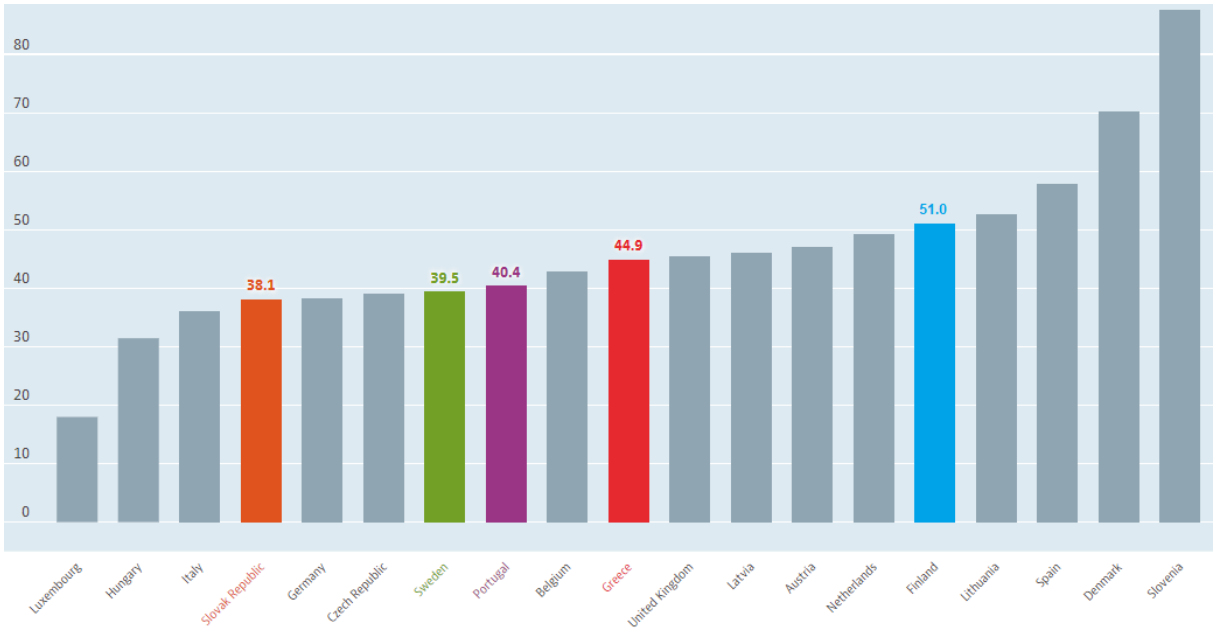


Fig. 3.5. Percentage of people with teritary education, source: own work, OECD



* Poland – 50%

Fig. 3.6. Tertiary graduation rate
source: OECD, 2016

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3.5 Co-operation between academia and mining and metallurgy industry

Co-operation between academia and mining and metallurgy industry in MIREU regions has several forms:

1. Cooperation with industry representatives, in order to:
   - exchange of information on the expectations of employers towards graduates;
   - gathering opinions about the proposed directions of the faculty's development and ways for implementation;
   - cooperation in adapting the educational, training and research offer to the current needs of enterprises, among the extractive industry and environmental protection;
   - participation in the education process through periodic lectures for students and employees presenting the current state of the industry and its most important directions of development and related educational needs;
   - joint organization of specialist trainings for students and employees.
2. Signing agreements with employers in the field of scholarships, apprenticeships and technical internships.
3. Providing materials for engineering and diploma work.
4. Organizing job fairs enabling students to familiarized with the expectation from the industry.
5. Conducting doctoral theses by employees employed in the mining and metallurgical industry.
6. Taking internships of employees in enterprises.
7. Co-organization of scientific seminars and conferences.
8. Implementation of joint research and implementation projects.

Research shows that universities and mining and metallurgy industries try to establish gateways for communication (e.g. by signing agreements, sponsorship, training visits, lectures and conferences) but only a small percentage of them actually collaborate in regards of training and hiring students in their companies.

3.6 Employment rate after education

Data on the level of employment after completing education are generally missing in European countries. If any data exists, it is very general or selective. Some of the universities conduct such research, but it is carried out through surveys or telephone calls, in which not all graduates want to take part. It is also very time-consuming, which may discourage institutions from collecting such data. Also, information about employment after education is provided by universities on request (only some general data can be found online). Therefore the situation is presented here only for Poland and Finland.

According to the more detailed study conducted by the Lower Silesian Regional Labour Office, mining is defined as a profession in which there is a balance when it comes to the demand for employees (Barometr Zawodów, 2017). Tables 3.6 and 3.7 show percent of employment among graduates of AGH-UST (after II level of education) and WUST (after I and II level of education). Figure 3.7 shows selected mining and metallurgy employers for AGH-UST graduates in 2017. One of them is KGHM Polska

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Miedź S.A. operating in Lower Silesia, but most of them are mining companies related to hard coal, oil and gas as well as industrial minerals extraction (KW S.A., PGNiG, LWB S.A., JSW S.A., KHW S.A, Tauron Wydobycie S.A).

Table 3.4. *Percent of employed graduates from AGH-UST.* source: AGH Career Centre, 2017

Year	2009**	2010	2015	2017
Number of graduates	3 430	3 650	9 439	9 975
Employment [%]*	74,5%	79,4%	88,2%	89%

Table 3.5. Percent of employed graduates from WUST. source: WUST Career Centre, 2016

Year	2013**	2014	2015	2016
Number of graduates	7 435	7 492	7 732	8 198
Employment [%]*	83,54%	74,34%	69,60%	77%

*employment + self-employment; **beginning of collecting data

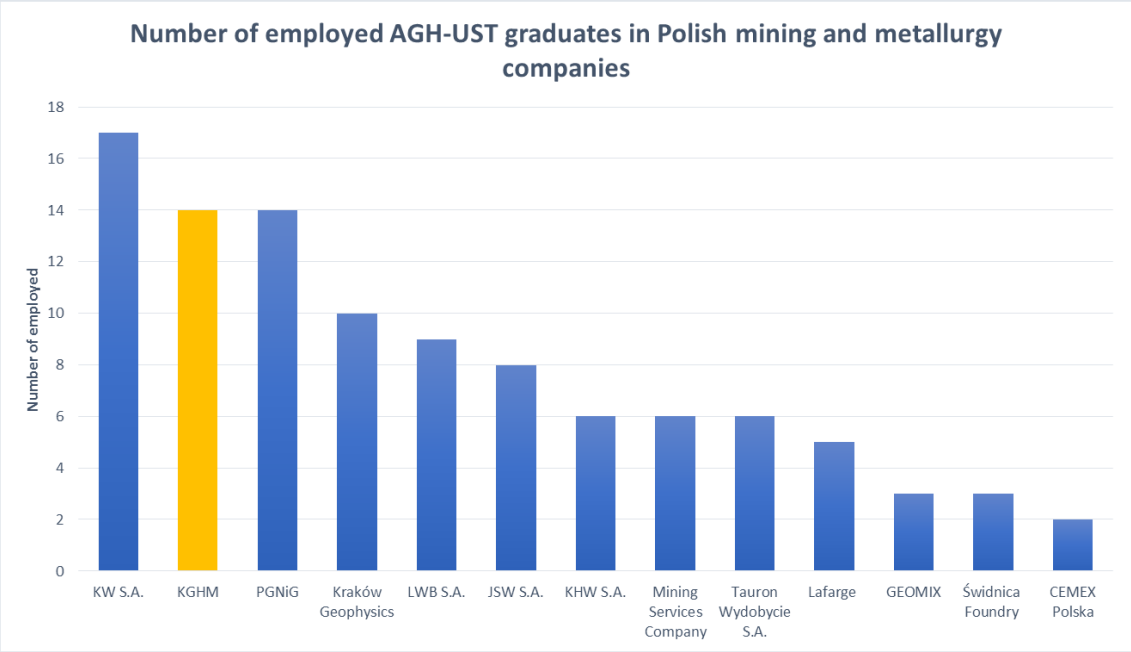

Fig. 3.7. Number of employed AGH-UST graduates in Polish mining and metallurgy companies source: AGH Career Centre, 2017

In Finland, employment rate after graduation is highest for higher degree employees, but in 2017 the employment rate of the lower degree employee increased the most, by 5%. In overall the employment rate is higher for women (73%) than for men (65%). In one year after the graduation 86% of the employees with either OAS or higher MSc University degree were employed, whereas the lower degree the employment rate was 70% (Vipunen, 2019; Official Statistics of Finland 2019).

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3.7 International courses in the field of education in mining and metallurgy

Students around the world can participate in various types of courses organized by universities, as well as in the frame of international initiatives such as EIT RawMaterials. Some examples of these courses are demonstrated in the table 3.9.

Table 3.9. International courses in the field of mining. source: own study

Name of the project	Initiative	Duration	Web page*
Summer School of Mining Engineering	AGH-UST	Since 2009 Once a year Duration: two weeks	http://www.gorn.agh.edu.pl/en/ssme
European Mining Course	EIT RawMaterials EIT-Labelled Master Programmes	Upcoming edition: 2020-2022	https://eitrawmaterials.eu/eit-rm-academy/labelled-masters/ http://www.emc-master.eu/
Master in Advanced Materials for Innovation and Sustainability (AMIS)	EIT RawMaterials EIT-Labelled Master Programmes	September 2019-2021	https://amis-master.eitrawmaterials.eu/study/#overview https://amis-master.eitrawmaterials.eu/
Summer school: The RACE for students EIT RawMaterials Academy	EIT RawMaterials EIT-Labelled Master Programmes	August 2020 Two weeks	https://eitrawmaterials.eu/eit-rm-academy/labelled-masters/ https://www.facebook.com/rawmaterialsacademy/
International Doctoral School in Functional Materials: Research and Innovation	EIT RawMaterials EIT-Labelled PhD Programmes	Duration of the course agreed with the partner	http://idsfunmat.u-bordeaux.fr/index.php/ids-inno-home
Fostering innovation-driven entrepreneurship in the raw materials sector in schools and universities	EIT RawMaterials JA Europe	Autumn 2019 - summer 2020	https://eitrawmaterials.eu/eit-rm-academy/eit-rawmaterials-and-ja-europe/ http://www.jaeurope.org/
SusCritMat – Sustainable Critical Raw Materials	EIT RawMaterials RawMaterials Academy	Online learning	https://suscritmat.eu/video-learning-content/
Wider Society Learning RM@Schools	EIT RawMaterials Raw Material Accademy	2016 to now	https://eitrawmaterials.eu/eit-rm-academy/wider-society-learning/ http://rmschools.isof.cnr.it/index.html
DIM ESEE: Dubrovnik International ESEE Mining school	EIT RawMaterials	1.04.2016 – 1.04.2021	https://www.rgn.unizg.hr/en/studies/lifelong-learning/dim-esee-dubrovnik-international-esee-mining-school https://eitrawmaterials.eu/project/dim-esee/
ESEE Education Initiatives	EIT RawMaterials	2019	https://www.facebook.com/pages/category/Education-Website/WGiG-AGH-ESEE-Education-initiatives-631787697352768/
MiReBooks: Mixed Reality Handbooks for Mining Education	EIT RawMaterials	2019	https://eitrawmaterials.eu/course/mirebooks-mixed-reality-handbooks-for-mining-education/ https://graz.pure.elsevier.com/en/projects/mirebook-mixed-reality-handbooks-for-mining-education
RawMaterials@Schools-ESEE	EIT RawMaterials	2020	https://rmschools.isof.cnr.it/

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TrainESEE	EIT RawMaterials RIC - Leoben	September 2017 – September 2018	https://www.ric-leoben.at/eit-raw-materials/raw-projects-en/
Mine Emergency Response (MINERS)	EIT RawMaterials RIC - Leoben	January 2018 – December 2019	https://www.ric-leoben.at/eit-raw-materials/raw-projects-en/
RawD Trip Summer School	EIT RawMaterials WGiG AGH - UST ESEE Education initiatives	2019 to now First edition: 2-13 September 2019	http://wggg.pwr.edu.pl/wydarzenia/rekrutacja-na-szkole-letnia-rawd-trip-summer-school-2019-93.html https://www.facebook.com/events/krak%C3%B3w-poland/rawdtrip-summer-school/475875623187631/
EIT MOBI-US	EIT RawMaterials AGH – UST University of Miskolc, Wroclaw University of Science and Technology, University of Zagreb	2020 Project in progress	https://eitmobius.eu/pl/przeglad-projektu/
EnAct-SDGs	EIT RawMaterials University of Athens AGH – UST Technical University of Kosice	2020 Project in progress	https://rcgreece.labmet.ntua.gr/call-for-ris-task-partners-in-enact-sdgs-project/

* Access to websites on 25.01.2020

3.8 Conclusion

Based on the data collected by MIREU partners, it can be concluded that communication between mining companies and universities is lacking. Therefore, the education and the number of students admitted do not adapt to the actual market demand. Cooperation between companies and universities aimed at training future employees is often only formal. Universities do not always publish data on the number of graduates of particular majors or do not collect them at all. Lack of data makes it impossible to accurately assess whether there is a surplus or shortage of people with education focused on mining and metallurgy (as well as related fields) on the market. Higher education institutions and vocational schools do not collect data on the employment after graduation or do not receive adequate amount of data in surveys they carry out. Therefore the universities are not able to adjust the university vacancies to the actual market demand. It is possible to find general or selective information, but it is insufficient to ensure fruitful cooperation with companies to meet the needs of employment in mining and metallurgy.

In many countries there is a significant drop in the number of students, which is most probably caused by a demographic decline, since the statistical data show that the percentage of people with higher education is systematically growing. The interest in fields of study related to mining and metallurgy is also low, possibly due to decline of the industry in early 2010's, and to negative reputation of the industry. Studies related to the environment, as well as machine construction and automation are of more interest, because they are applicable not only in mining and therefore widening the job opportunities for the graduates.

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4. REGIONAL BASE FOR ACQUIRING SKILLS

4.1 Identification of vocational training in mining and metallurgy and its connection to academia and industry

Data analysis shows that the offer of vocational schools in most countries mainly includes professions related to mechanics. Specializations related to mining and metallurgy can also be find, but they represent a smaller percentage.

Alentejo region, Portugal

According to the research conducted to elaborate the present report in Alentejo there are two institutions that provide professional training: EPDM - Company of Drilling and Mining Development, S.A. and Litoral Alentejo Techonological School (ETAL).

EPDM offer vocational training on mining. According to their website, they promote tailored training according to specific needs of each company and associating the actions with the productive operations. They have carried out training/awareness actions covering 376 employees, and a volume of 37,608 hours of training in several areas, such as: quality, environment, safety and emergency; Mining Equipment Operators; Operators of Surface Equipment; Explosives Operators; Computer science and new technologies; Behavioural area; Foreign languages.

ETAL areas of expertise are focused on industrial technologies, namely: Automation and Industrial Instrumentation; Industrial chemistry; Laboratory Analysis; Mechatronics, Mechanics and Electricity; Hygiene and Safety at Work and Environment; Computing

In general, the access to professional knowledge on the mining sector seems reduced, yet, according to Lundin Mining (2018), Somincor has not historically had any difficulties recruiting staff for the Neves-Corvo mine.

Košice region, Slovakia

Professional training in metallurgy is carried out at SOŠ Učňovská 5, Košice – Šaca, which prepares experts in the fields of metallurgy, engineering and electrical engineering (metallurgical operator, machinery and equipment mechanic, programmer of machining and welding machines, mechatronics mechanic, computer network mechanic, mechanic electrician). The school is a center of vocational training for the engineering and metallurgical industries. Its graduates are employed by U.S. Steel Košice and its subsidiaries (with the exception of those who continue their studies at the university). Cooperation with the U.S. Steel Košice is at a high level and has a steady form.

There is no professional training in mining in secondary schools in the Košice region. Mining education is only partially covered at the Secondary Technical School construction and geodetic in Košice. In the degree programme geology, geotechnics and environmentalism (very marginally related to mining), there is no vocational training in the classical form.

Lower Silesia region, Poland

Technical school (in Polish: technikum) is a 5-year secondary school with a technical profile. Completing technical school allows to obtain a diploma confirming professional qualifications (after passing the exam) but also allows to take matura

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exam and continue education at university. Another type of secondary school is Vocational Education and Training (VET) school of first stage (3 years) and second stage (2 years) (in Polish: Szkoła Branżowa I i II Stopnia).

There are 88 schools in Lower Silesia that offers vocational education in mining and metallurgy (16 specializations) and related fields (155 specializations, mainly mechanical and electrician technicians). The number of practical training hours depends on the course, programme and type of school. Some of schools prefer short-term practice (for example one month) and other obligate pupils to work for one/two days of a week or every day for a few hours. It is also a common practice at VET schools to sign a contract of employment with chosen company for the entire period of study.

Sterea Ellada region, Greece

In Greece to be licensed for technical profession, student must complete Upper - Secondary education (in General or Vocational schools) or the formal Secondary Vocational Training (at EPAs of OAED) or the Institute of Vocational Training (I.E.K.), where they have the opportunity to exercise technical professions. The supporting documents for the personnel licenses are submitted to the Directorate of Development, of the Regional Unit. If the supporting documents are valid, the announcement of a personnel exercise-license is realized within a month allowing the candidates to exercise the specific profession as assistants, under the supervision of a licenced professional. Upon the completion of 300-450 workdays for the graduates of Upper – Secondary education or 70-150 workdays for graduates from Vocational Schools, EPAs and I.E.K., the candidates are allowed to participate in dedicated exams in order to become fully licenced professionals. The exams are implemented at the seat of the Regional Unit and the authorization/certification for exercising their specialty profession is rendered by the Directorate of Development, of the Regional Unit. It is estimated that the number of issued licenses is 500 per year. Nevertheless, for the 2019, the estimated number was double the estimated, due to the fact that graduates from many fields of specialization were not examined during the previous years.

Lapland, Finland

There are currently seven educational institution providing mining related vocational training in Finland. The institutions are mainly owned by the regional governments which plan their education to serve the regional workforce needs. In fact, the vocational education and training is crucial part of the regional development. There is not concrete coordination between different institutions such is between different universities and universities of applied sciences. All vocational mining education institutions are independent, owned by municipalities or joint municipal authorities. They have their own administrations and approved budgets to make quite independent decisions. Therefore, there are also large differences in machine and equipment resources acquired for educational purposes. However, as the mining sector's training needs are quite limited nationwide, the most important sourcing tools should be designed as a whole, not as institution wise. Promoting the shared use of machine and equipment resources in educational institutions should be encouraged. Mining companies, as employers in the industry, sometimes report that some of the trainees are not capable for demanding hard work, and that this is only observed at that time. Of course, such a situation does not benefit the employer, the educational institution, and especially the student himself (Josek 2017).

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Norrbotten and Västerbotten regions, Sweden

Technical training for the mining industry in Sweden occurs at the university level.

4.2 Co-operation between vocational schools– academia – mining and metallurgy industry

Lower Silesia region, Poland

In Poland, the most common form of cooperation between vocational schools and industry are patronage classes. The patron offers pupils training in their company, learning materials and sometimes also employment after graduation. There is no detail analysis concerning needs from mining and metallurgy industry and possibilities of employment. Unfortunately, this form of cooperation is often only formal or required by law and does not lead to the actual employment of vocational school students in mining & metallurgy companies.

Košice region, Slovakia

In Košice, the last years no vocational school or other secondary high school is preparing the students for mining profession. New applicants for mining profession need to be prequalified directly by the mining companies. In the university education only the FBERG (Faculty of Mining, Ecology, Process Control and Geotechnologies) is preparing the students for the practice in the mining sector. Secondary vocational school oriented on metallurgy is the only one high school in Košice region connected to the employer in the sense of exchange agreement between the U. S. Steel Košice and the vocational school Učňovská 5, Košice. This school is providing training for the future employer under the mentoring of professionals from U.S. Steel Košice.

Lapland region, Finland

In Finland the higher level institutions cooperate with the industry especially in research. On job learning is often compulsory part of the education and especially in field of mining and metallurgy, it is common that many of the bachelors and masters thesis are made for the mining companies. The machinery and equipment industry is significant to mining industry and thus also to development of the mining related education. Therefore, many vocational colleges have been cooperating with major machine and equipment suppliers for a long time (Josek, 2016). The mining companies are also sometimes funding the universities.

Regional data from other countries is missing.

4.3 Employment rate after training

Košice region, Slovakia

The overall applicability of graduates up to 5 years after school termination is slightly lower and slightly improving with increasing labor market time. However, the overall result is not very optimistic, as up to 60.3% of secondary school leavers have been employed outside their field of study

Lower Silesia region, Poland

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Data about employment rate after training in vocational school are not available from both Main Statistical Office and schools. Based on general research done for Lower Silesia, almost half of the surveyed schools indicated that 50% or more of the pupils found a job up to 12 months after the end of training. Only 5% of schools answered that none of their graduates found work within a year of leaving school. Those data are general for each field of school (Analiza potrzeb szkół zawodowych pod kątem wyzwań regionalnego rynku pracy, 2015). Employers indicate that the programme of vocational schools in Poland is not adapted to the needs of the industry. Only 8% of technical graduates have practical classes and only half of them pass a vocational exam (www.tvp.info/30795905/szkolnictwo-zawodowe-w-kryzysie-tysiace-uczniow-bez-potrzebnych-kwalifikacji).

In Poland, in one of ten vocational schools, none of their graduates continued their education in other schools. However, in every fifth school there were 11-20% of such pupils, 17.3% of schools indicated that there were 21-30% of them and 16.2% of schools indicated that there were 31-40% of such pupils.

20% of schools declares that up to 20% of graduates did not continue education or found employment within 12 months of leaving education. 30% answered that there were less than 10% of them. 17.9% of schools claim that there were no such graduates. Those data are general for each field of school (Analiza potrzeb szkół zawodowych pod kątem wyzwań regionalnego rynku pracy, 2015).

The level of data collection on the fate of graduates of vocational schools is even lower than in universities. Sometimes only general data is available on the number of people who graduated from school. Telephone conversations conducted by AGH-UST with the school principals showed that such statistics are not being carried out. Schools are also not interested in whether their offer meets the needs of the labor market.

Lapland region, Finland

According to poll send to Finnish vocational schools offering mining related education and training, the employment rate of the graduates in mining sector is 100%. In 2019, there were 10 015 unemployed mining personnel in whole Finland and 454 in Lapland. Between 2014 and 2016 the employment rate of the lower degree miners has increased. The graduates with specialized education degree in mining became employed easier than the graduates with just basic education in mining. In addition, the graduates with lower degree in mining tend to be employed easier than the lower degree graduates in overall in Lapland (Vipunen, 2019; Official Statistics of Finland, 2019).

Regional data from other countries is missing.

4.4 Training organized by the mining and metallurgy industry

Košice region, Slovakia

Training provided within the industry is tailored for the needs of specific job position and this is ensured by employee either by own internal training or in case of operating a new mining equipment, by external partners, mostly the dealer. Necessary trainings, such as occupational safety and health or requalification, are provided by standard external institutions that have a wide range of trainings.

The main problem of training for professionals is that in the sector of mining and metallurgy there is a demand of highly specialized or tailored training. Such kind of

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training is mostly provided in English, which is a barrier for the employees of the sector. Thus in this segment there is a real demand for making the training in domestic language.

Lower Silesia region, Poland

Training organized by the mining and metallurgy industry is presented on the basis of the largest mining and metallurgy company in the region – KGHM Polska Miedź S.A. Company invests in the continuous professional development of the staff. KGHM is carrying out some programs to build competences among employees, such a Human Capital Management, Mobility Policy and program of co-financing for higher and postgraduate studies. They provide periodic occupational health and safety (OHS) trainings, courses and examinations entitling to work on specialist positions, as well as other development activities, with particular emphasis on management and interpersonal skills as well as trainings on process management and Lean Management. Employees have also the opportunity to improve their skills in the context of organizational and technological changes. In recent years, projects enabling the exchange of knowledge and experience between employees have been implemented. Number of training hours in KGHM Polska Miedź S.A. is shown table 4.2.

Table 4.2. Training hours in KGHM Polska Miedź S.A.

	Total number of training hours by gender					
	2016			2015		
	Women	Men	Total	Women	Men	Total
Total number of training hours	22 891	551 438	574 329	36 584	533 736	570 320
Number of employees	1 300	16 963	18 263	1325	16 901	18 226
Average number of training hours by gender	17.61	32.51	31.45	27.61	31.58	31.29

source: Integrated report of KGHM Polska Miedź S.A., 2016

Sterea Ellada region, Greece

In Greece, Industries related to mining and metallurgy sector tend to retain their staff and this fact enhances the development of training programs for employees in order to be able to meet with the needs of new knowledge and skills. According to the same report, 30% of Greek industries have difficulty to fill posts at their companies, with the main cause being the skills shortages of the staff. Other causes are the lack of the required working experience, as well as the high level of competition from other companies and the low salary levels. According to ELSTAT estimations, in a country level, the number of the workforce in the sector of mines and quarries that is participating in training programs of typical or not typical educational system is characterized by low level (less than 10%) (ELSTAT, 2016; SEV, 2019).

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Furthermore, five of ten companies highlighted the lack of skills of their staff. The category of industrial facilities operators was identified as the one with the greater deficiencies in knowledge and skills (technical/professional knowledge, foreign languages and teamwork). As a result, industries try to organize training programs and seminars, purposing on the attendance of vocational and theoretical courses by their staff in the framework of basic and special training. According to the data collected by the following questionnaire, industries spend less than 100 hours per year for each employee for the training programs and seminars.

The training seminars and programs are mainly related to Health and Safety as well as to Human Capital Management. Apart from the categories referred to the questionnaire, other training courses focused on Technical and Professional issues, Induction training, Informatics, New Technologies, Management, etc. are realized. According to the latest data collected by SEV, 80% of industries have organized training programs. The main sectors of the training are: Health and Safety and Development of technical/ professional skills of their human resources. Finally, with regards to the employees' opinion, the sector they exhibit the most interest in is Health and Safety.

Portugal

In Portugal, according to the interviews, mining knowledge is often transferred between workers. Companies employ local communities and therefore frequently more than one member of the family works in the mine. Thus, old generations train new employees passing their experiential knowledge informally.

Provided training is focused on health and safety (OHS). There are also courses of entrepreneurship and economic diversification that aimed to train and support business leaders. Example training include: entrepreneurship, innovation and creativity, marketing, strategic innovation and business development, business plan, finance, presentation skills, measurement of commercial performance, technologies and web applications.

In general, companies tend to train employees mainly in OHS to improve safety at the workplace. The basic qualifications connected with employees occupation are rarely being developed. The management staff is usually trained in soft and business skills. The training options depend mainly on employers and usually do not go beyond improving the basic skills of employees.

Finland

Because of the extensive recruitment needs of the extractive industry in Lapland, the educational institutions have not been able to produce enough educated labour. Therefore, there has been collaborative training courses jointly funded by the state and the employers that have been utilized in Lapland for example, recruiting workers for the Kittilä (in 2007–2008) and Kevitsa mines (2011-2012). Also Driver Training for Mining Machines for Women has been implemented in collaboration with Kevitsa mine, which has produced a specific basic know-how in transport operations at a mine. In addition, a basic mining training has been implemented as a general labour force training at the region. In addition to this, at the beginning of 2013, the Vocational College Lappia started on the initiative of the Office for Employment and the Economy, Laboratory Training for the Mining Industry. Whereas, the Lapin Letka project in 2012-2014 aimed in promoting gender equality in education and at workplaces also in mining sector (Pudas et al., 2013).

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Usually the mining companies offer training on Health and Safety for the whole staff. Specialized training is targeted for selected employees based on the needs. This type training could be for instance laboratory and processing plant work.

5. SKILLS REQUIREMENTS FOR REGULATORY AND ADMINISTRATIVE BODIES

5.1 Introduction and Method

Regulatory and administrative bodies play great role in access to mineral deposits as well as efficient mining and metallurgical operations. Therefore their education and skills – having influence also on awareness of the importance of minerals for the economy – are very important. In this chapter the regulatory and executive authorities which are involved in **permitting procedures** (obtaining: license for prospecting for, exploration and extraction, environmental decision[1], decision on reclamation[2]) or **supervision** are presented in the context of their education and skills.

The methods differed between country reports and generally contained:

- Analysis of legal provisions.
- Analysis of job advertisements.
- Surveys among employees of offices participating in permitting procedure via questionnaires and telephone conversations.

5.2 Skills analysis of regulatory and executive authorities

Poland

The regulatory and executive authorities are exercised by public administration: government (at the national level) and self-government (at the level of voivodeships, counties (powiaty) and municipalities). Regulatory authority at the country level is exercised by the Seym (the lower house of the Polish Parlament) and the Senate (the higher house of the Polish Parlament). In the responsibility of the Seym and the Senate is issue laws in force throughout the country – acts (ustawy), e.g. the Act in Geological and Mining Law and executive acts to them – regulations (rozporządzenia). Regulatory authority at the regional level is the Voivodship Board (Sejmik Województwa), at the local level the County Board (Rada Powiatu) and the Municipal Board (Rada Gminy) (Fig. 5.1). In the responsibility of the Voividship Board, County Board and the Municipal Board is to pass legal acts which force in the area of the bodies that set them up, e.g. land use planning documents, resolutions on the protection of valuable natural areas, or development strategies etc.

Members of Seym, Senate, and Boards are elected by the community in general elections, their education and skills in a specific field is irrelevant. Draft laws and

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regulations are prepared by the Legal Department of the Ministry of the Environment in cooperation with other departments. In some cases, so-called pre-consultation with the mining industry and the social entities are conducted. There are no legal requirements concerning education and skills for employees of departments in the Ministry of the Environment (and others ministers related to mining activity).

However there is practice, for example to employ lawyers in the legal department. Since 2017, in the Ministry of the Environment has been operating a team for the revision of competences of geological administration bodies, which is working on the concept of geological and mining law reform. Besides, during the legislation procedure draft of laws and regulations are widely consult with stakeholders. Requirements (fields of education and qualifications) for persons elaborating spatial documents are specified in the Act on Land Use Planning and Spatial Management.

The executive authority involved in the permitting procedure are presented in the table 5.1. In Poland the procedure of obtaining a license, and thus the involvement of administrative bodies, depends on ownership of minerals (state owned and ground owned) as well as type of minerals, size of mining plant, annual output, technique of extraction and location of deposit (within or outside the boundaries of the maritime areas of the Republic of Poland). In general, authorities at each level (government e.g. ministers and central offices, at the regional level - the marshal (marszałek), at the local level - heads of district (starosta) and at the municipal level by head of municipalities/mayor/city president (wójt/butmistrz/ prezydent miasta) can be involved in permitting procedure. As they are nominated by the President of Poland (in case of ministers) and elected by the community in general elections, their education and skills in a specific field are irrelevant.

The executive authority operates with the help of offices such as departments in the ministry, voivodship and county geologists, county and municipality offices. Therefore, the staff occupying the positions in the aforementioned offices supporting the permitting procedures through analysis of documents and preparation of draft decisions was subject of analysis made in the case of Poland. Results are presented in the table 5.1, and details in Country report of Poland.

With reference to positions which were taken in the environmental protection directorates, in July 2018 job advertisements were reviewed in all 16 directories in Poland. On the basis of 53 job advertisements for positions related to the procedure of environmental impact assessment and to the issuing of environmental decisions, the required education was characterized. Information on trainings raising qualifications and skills for employees of regional directorates of environmental protection were obtained through telephone interviews.

In case when administrative body (executive authorities) involved in permitting procedure are nominated or elected by the community in general elections and their skills are irrelevant, qualification of departments staff are important. The results of research conducted in Poland, in the Lower Silesia region indicate that very rarely employees of departments participating in permitting procedures have education in the field of mining and geology. However, the majority of staff regularly participate in training that raises qualifications and is willing to continue. Frequency of participating in trainings is different: 1 every 2 years, 2 or several times a year or according to the need, e.g. change of regulations.

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County and municipality offices were subject of survey conducted in Poland. Conclusions are as follow:

- Almost all employees participating in the permitting procedure have higher and postgraduate education mostly in the field of Protection of Environment or Environmental Engineering. There is relatively few people with geological and mining education in municipal offices in which geological and mining activities are carried out. In a few municipalities, analysis of documents related to geological and mining activities is outsourced to specialists.
- The majority of staff regularly participate in training that raises qualifications and is willing to continue. Topic that causes them the most problems is the environmental impact assessment. Besides they participate in the trainings in the field of: geological and mining activities, reclamation, land management, environmental protection, administrative procedures, spatial planning, nature protection or waste management.
- It is a concern, that there are municipalities in which geological and mining activities are carried out, and there are no competent staff in the offices, and they do not express interest in training.

Sweden

In Sweden, the basis for all kinds of permit requirements is the need to control the activity from different perspectives, e.g. prevent environmental damage, facilitate development and ensure that different interests are considered. The licensing of mining activities is a rather complicated process that involves assessments by different authorities in accordance with several laws.

Greece

In Greece, the permitting procedure in the Non- Energy Extractive industry involves authorities from three levels: central, regional and local, namely:

- The Ministry of Environment and Energy (YPEN) at the national level
- the 7 De-centralised (Regional) Administrations (tiers of ministries)
- the 13 Administrative Regions.

According to Greek law, there are no specific requirements for the employment in Administrative or Regulatory Bodies related to Raw Materials.

Portugal

In Portugal, permitting procedure is administered at the national level – by the General Directorate of Energy and Geology (DGEG) under the direct supervision of the Ministry of Environment and Energy Transition (MATE). Integrated environmental permit (Environmental License) is reviewed by both the DGEG and the Portuguese Environment Agency (Agência Portuguesa do Ambiente, APA). Environmental Impact Declaration is issued by the MATE after the approval of the Environmental Impact Assessment Procedure.

Finland

The Ministry of Employment and the Economy is responsible for the general guidance, monitoring and development of activities under the Mining Act. Whereas, the Finnish Safety and Chemicals Agency (TUKES) acts as the mining authority.

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TUKES is responsible for granting mining and exploration permits and supervising and enforcing compliance with the Mining Act. Any matters relate to radioactive substances, including uranium mining, is the responsibility of the Radiation and Nuclear Safety Authority of Finland (STUK). STUK operates under the Ministry of Social Affairs and Health.

The Centres for Economic Development, Transport and the Environment (ELY Centres) are responsible for the regional implementation and development tasks of the central government in Finland. ELY Centres supervise adherence to the environmental and water permits granted by Regional State Administrative Agencies (AVI) and ensure that public interest is taken into account in environmental and water issues. Thus, ELY Centre is the organization in Finland responsible supervising that the mine companies are operating according to their environmental permits. Local municipalities are responsible for their own detailed planning and are also the authorities granting building permits.

The positions for mining authorities in Finland are chosen by public job applications. There are no set skills requirements for positions, and every open position is handled individually. Usually the candidates are expected to have higher education in relevant field of studies such as geology, mining engineering or environmental studies, as well as previous experience on similar work. There are no legal requirements concerning education and skills for employees of departments in the ministries (and others ministers related to mining activity) but same procedure as with other authorities applies, the applicant should have adequate higher education and enough work experience. Ministries prepare all laws for the government‘s approval.

In the context of raising education and skills of relevant authorities it is worth mentioning the experience from Finland, which is connected with the accident occurred at Talvivaara mine in November 2012. After this, the Ministry of the Environment set an authority working group to deal with topical issues related to environmental safety of mines (KYTU working group). The KYTU working group assessed the means to prevent environmental incidents and proposed launching a mine specialization program of three northern ELY Centres. Therefore, the Ministry of Economic Affairs and Employment, Ministry of the Environment, Ministry of Agriculture and Forestry and Ministry of Transport and Communications decided on 2014 that the ELY Centre for Lapland will coordinate the planning of mine specialization program of the Lapland, Kainuu and North Ostrobothnia ELY Centres. The aim was to increase the cooperation and sharing of good practices between the authorities and harmonize the procedures. The mine specialization program was launched in 2015 and focuses for example on improving the supervision and inspection of mines, environmental impact assessments (EIA) of mines, cooperation between the mine supervision and permitting authorities as well as increasing the expert knowledge on mine environmental safety.

One key task in the mine specialization program is to **improve the expertise of mine authorities** by arranging lectures, seminars and workshops and by giving guidance and developing guides for best practices. From the year 2018, also consultants, mine company personnel and researchers have participated the lectures, either remotely by audio or in person. The lectures have been given by Finnish key experts and focused on best environmental practices (BEP) and best available technologies (BAT) in mine environmental safety in general, including extractive waste facilities and waste management, assessment and management of environmental impacts and risks, water balance, water management and treatment, mine closure and

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rehabilitation. The length of the lectures have been varying for couple of hours to two days.

During the year 2018 altogether ten video lectures (about 70 to 150 participants on every lecture), a seminar (Mine environmental protection day), a negotiation day and workshop for mine permitting and supervision authorities (including a mine visit) and a mine specialization program development seminar and workshop were arranged. The costs of arranging the video lectures and workshops are covered by the project "Development of environmental safety of extractive industry" that is funded by the development funds (OHKE) of the Ministry of the Environment, Finland. In addition to this project there are also four other OHKE-funded development projects ongoing in mine specialization program. Those include projects:

1) Guide for supervision of mines in bankruptcy situations and related environmental damage.
2) Guide for designing and constructing environmental waste facilities of mines.
3) Best practices and best available technologies in extractive waste management and
4) Developing life-cycle supervision of mines.

All these ongoing projects excluding the latter also include education events such as video lectures and workshops targeted to mine supervision and permitting authorities, personnel of mine companies, consultant and researchers.

5.3 Conclusion

Regulatory and administrative body play great role in access to mineral deposits as well as efficient mining and metallurgical operations – they shape legislation and grant decisions, which reflect their knowledge, skills and awareness or lack of them. In each of the analysed countries and regions, the administrative body (executive authorities) are exercised by the public administration: government (at the national level) and self-government (at the regional and local level). They as well as the members of regulatory authority and the practice of issuing laws and regulations are often elected by the community in general elections and due to this their education and skills in a specific field might be irrelevant. However good practice is carried out by consulting with stakeholders draft of laws and regulations. In the case of Poland and Slovakia, ministers operate with the help of geologists – education and skills for such position is required by law in Slovakia, and in Poland, as a rule, this position is occupied by a geologist. In case of Sweden Chief Mining Inspector grants license and there is no legal requirements for education and skills for such person. However, as in Finland, the permits are granted as wll as supervised by the authority, who have not been elected for their position, but chosen thorough public job application. For these positions a relevant higher degree education and work experience is usually required.

Good practice in improving education and skills of relevant authorities as well as consultants and environmental staff of the mines took place in Finland. A mine specialization program in Lapland, Kainuu and North Ostrobothnia ELY Centres was launched. The aim of this programme was to increase the cooperation and sharing of good practices between the authorities and harmonize the procedures. The lectures were organise in the form of: video, seminar, a negotiation day and workshop.

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According to Ministry of Labor, Social Affairs and Family of **Slovakia** the way of education as well as the requirements in relation to entrepreneurs and administration in the scope of performing their duties should be supplemented with creative and logical thinking. The current stage in the world development puts forward new requirements for the preparation of regulatory and administrative bodies, including technical ones. The possession of only specialized professional knowledge is no longer sufficient to be a competitive specialist. In the modern labor market, creativity and competence become basic individual psychological qualities that characterize the success of any professional activity. Creativity becomes the quality that provides an individual opportunity to adapt to the changing conditions of life and is the key to a person's success in professional activity. Creativity is an important factor in personal development. It determines the willingness of an individual to change and give up stereotypes. Therefore, the main task is the preparation of a competent, qualified graduate who can not only apply knowledge, abilities and skills, but also take original and non-standard solutions in situations arising in professional activities. (source: https://www.istp.sk/kartoteka-zamestnani)

Future of working posts according Grey (2016) identified 10 key skill and requirements for regulatory and administrative bodies:

- Complex problem solving.
- Critical thinking.
- Creativity.
- Human sources management.
- Coordination with other people.
- Emotional intelligence.
- Ability to make decisions.
- Orientation to the services.
- Ability to negotiate.
- Cognitive flexibility.
- Legal skills and requirements.

The rules and guidelines formulated in the Slovak ministerial law on education and preparation of legal regulations seem to be universal and useful in the field of permitting procedure. Requirements together with demands for flexibility show that only expertise is not enough. It is necessary to develop softs skills and to ensure mastery of key competences in order to be fully competent and broadly successful in praxis.

In this context:

- Universities should provide lectures with aim to help students to be prepared for specific condition at the job market, providing development of demanded broad competences, which make it easy to be orientated at the foreign market.
- There is necessary to create and to implement interdisciplinary knowledge to support development of business and global thinking, attitudes and competences of the regulatory and administrative bodies.

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Table 5-1. Administrative positions involved in the permitting procedures for exploration and exploitation and the required skills source: own work based on Country Reports

Country	Grants license for exploration	Grants license for extraction	Agrees the license for the minerals extraction	Grants the environmental permit	Grants spatial decision and building permit	Grants decisions on reclamation
POLAND	**Minister of Environment/Chief Country Geologist-Marshal/Provincial geologist** No legal requirements for education and skills.	**Minister of Environment/ Chief Country Geologist Marshal/Provincial geologist District Head/ District geologist** No legal requirements for education and skills.	**Head of the municipality** No legal requirements for education and skills.	**Regional Director for Environmental Protection.** There is legal requirements: - a diploma of higher education in a field that gives qualifications to perform tasks, - 5 years of training as a manager in the field of environmental protection.	**Head of the municipality and District Head** – based on a decision prepared by qualified and authorized employees.	**District Head** There are no statutory requirements regarding their education and skills.
PORTUGAL	**Ministry of Environment and Energy Transition (cooperation with DGEG which is under the supervision of the ministry).** No legal requirements for education and skills	**Ministry of Environment and Energy Transition (cooperation with DGEG which is under the supervision of the ministry).** No legal requirements for education and skills	n/a	**Portuguese Environment Agency** No legal requirements for education and skills.	n/a	**Ministry of Environment and Energy Transition** (cooperation with DGEG which is under the supervision of the ministry) No legal requirements for education and skills.
SWEDEN	**Chief Mining Inspector** No legal requirements for education and skills	**Chief Mining Inspector** No legal requirements for education and skills	n/a	**Land and Environment Court** No legal requirements for education and skills	**Municipal Building Committee** Chief Mining Inspector	n/a
GREECE	**The Ministry of Environment and Energy (YPEN) at the national level**	**The Ministry of Environment and Energy (YPEN) at the national level**	n/a	n/a	n/a	n/a

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	The 7 Decentralised (Regional) Administrations (tiers of ministries) **The 13 Administrative Regions.** No legal requirements for education and skills	**The 7 Decentralised (Regional) Administrations (tiers of ministries)** **The 13 Administrative Regions.** No legal requirements for education and skills				
SLOVAKIA	**Minister of Environment /** **Licensed chief geologist and his deputy head** Legal requirements in order to obtain geological license: higher education (master degree) in the field of geology or mining and geology; min. 3 years of work experience in performing geological works and passing the competency exams every 5 years.	n/a	n/a	n/a	n/a	n/a
FINLAND	**Finnish Safety and Chemicals Agency (TUKES)** No legal requirements for education and skills	**Finnish Safety and Chemicals Agency (TUKES) or Nuclear Safety Authority of Finland (STUK) in case of uranium** No legal requirements for education and skills	**n/a**	**Regional State Administrative Agencies (AVI)** No legal requirements for education and skills	n/a	n/a

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6. CURRENT AND FUTURE SKILLS REQUIREMENTS IN A MINING AND METALLURGY INDUSTRY

POLAND, LOWER SILESIA

Current skills requirements

One of the largest employers not only in Lower Silesia, but also in whole Poland is KGHM Polska Miedź S.A. The company employs over 33 000 people worldwide (in Europe, North and South America) and more than 18 000 in Poland. Also, KGHM Polska Miedź S.A. estimates that 200 000 people – indirectly or directly – have a job thanks to the whole capital group. Fig. 6.1 shows the number of employees in KGHM Polska Miedź S.A. in 2011-2016. The reduction of employment in 2014 is the result of a drop in copper prices, tax increase related to its extraction and huge company investments.

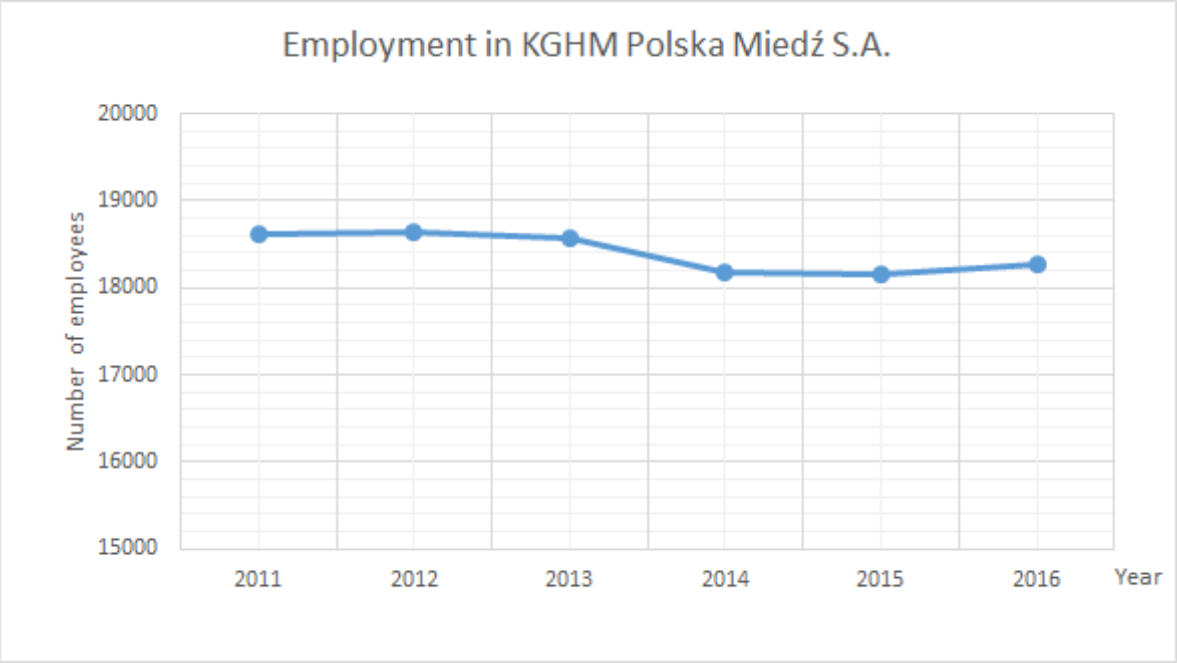

Fig. 6.1. Employment in KGHM Polska Miedź S.A.
source: own study based on Integrated reports of KGHM Polska Miedź S.A, 2011-2016

The table 6.1 shows that the number of non-physical workers in KGHM is decreasing, while the number of physical workers and management staff is growing. According to the recruitment portal (June and November 2018), the most desirable specialists at KGHM are ironworkers/welders and electricians. Most of the offers are dedicated to physical workers (source: https://rekrutacja.kghm.com).

Activities involving the automation of underground work do not cause a significant reduction in employment. This is due to the fact that the employee is not replaced by the machine, but his position is transferred to the surface. A manual worker is replaced by an employee whose tasks include controlling and monitoring the operation of the

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device. The conclusion is that despite the demand for developing new technologies, the need for white-collar workers is not growing. Also, company is looking for specialists who have completed technical vocational schools, not necessarily miners.

Table 6.1. Number of employees divided into categories. source: Integrated reports of KGHM Polska Miedź S.A., 2014 – 2016

No.	Employees category	Number of employees		
		2014	2015	2016
1	board of directors	5	5	5
2	senior management	50	50	54
3	other management staff	560	944	998
4	non-physical workers	4 096	3 742	3 690
5	physical workers	13 457	13 458	13 516

Future skills requirements

The company is constantly looking for solutions and technologies that on the one hand will contribute to lowering production costs, and on the other hand will allow for a higher recovery of copper and associated metals. The long-term challenge for the company will be to reconcile innovative solutions (e.g. robots) with keeping employment of miners. There are also "smart mines" in plans, where physical work will be partially replaced by intellectual work. These will be plants equipped with modern machines for mining rocks. They recognize the level of copper content in the ore, hardness, humidity and other parameters and program themselves to the collected data. Therefore, the implementation of innovative solutions will mean in the following years reduction of employment of manual workers.

In order to preserve the requirements of work safety during the exploitation of deposits in increasingly difficult mining and geological conditions (increasing depth of deposits, higher temperature of the rock mass and the growing threat of rock bursts), KGHM Polska Miedź S.A. is carrying out the research in the field of developing alternative hard rock mining technologies against the commonly used shot technique. In addition, research is also underway to improve the quality, conductivity, strength and efficiency of copper products and its alloys.

According to statements included in Integrated Raport of KGHM Polska Miedź S.A. (2016) the company predicts the increase of the value of activities in three key areas that are important for sustainable development:

- Socio-local - cooperation with local communities.
- Technical and economic - employee safety and rational, economic efficiency supported by the use of the latest technologies.
- Ecological - minimizing the negative impact on the natural environment.

Employee safety occupies the first place in the value hierarchy of the KGHM Polska Miedź SA Group. It is also one of the pillars of their Responsible Business Strategy. The company also focuses on major R & D initiatives to improve work safety. On this basis, it can be predicted that in the future employers will be looking for soft skills - social, economic, related to environmental protection and work safety.

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SWEDEN, NORBOTTEN and VÄSTERBOTTEN

Current skills requirements

Mining has a stronger indirect impact on employment in Norrbotten than in Västerbotten county. The estimated multiplier effect of mining on non-mining sector employment was 0.99 for Norrbotten compared to 0.85 when both counties were included in the specification. These results suggest that every 100 mining jobs in the Norrbotten county generates nearly 100 additional jobs in other sectors. There are several factors that may contribute to this result:

- The mining industry is overall a much more significant employer in Norrbotten than in Västerbotten. In 2012, Norrbotten accounted for approximately 82% of all mining employment in Northern Sweden.
- While mining is an important specialization in both counties, it represents a more distinct specialization in Norrbotten.
- Mining in Norrbotten county is dominated by iron ore which is a bulk commodity. In Västerbotten, the mining industry extracts base and precious metals which are not as bulky materials as iron ore. This suggests differences in infrastructure needs and logistics operations, and this may contribute to the stronger employment impact of mining in Norrbotten compared to Västerbotten.

Table 6.2. Job Multiplier Estimates: the mining sector versus non-mining sector. source: Sweden Country Report

Model specifications	*t*-statistics	Elasticity	Job multiplier
All municipalities in both counties	0.97	0.00648	0.352
Mining municipalities in both counties	2.48	0.03429[a]	0.852
All municipalities in Norrbotten only	2.06	0.03158[a]	0.989

[a] Statistically significant at the 5 % level

Table 6.3. and Table 6.4. Job Multiplier Estimates: mining municipalities in both counties and in Norrbotten only. source: Sweden Country Report

Sectors	*t*-statistics	Elasticity	Job multiplier
Industrial sector	1.95	0.04871[a]	0.426
Private services	4.55	0.09203[b]	0.634
Business sector	1.81	0.03730	0.201
Government services	−1.91	−0.01408	−0.238

[a] Statistically significant at the 10 % level
[b] Statistically significant at the 5 % level

Sectors	*t*-statistics	Elasticity	Job multiplier
Industrial sector	1.39	0.03376	0.202
Private services	2.25	0.06429[a]	0.662
Business sector	1.54	0.04691	0.201
Government services	−1.54	−0.01684	−0.242

[a] Statistically significant at the 5 % level

Future skills requirements

There is a positive statistical relationship between increases in the number of employees in the mining sector and changes in the number of employees in other

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sectors in northern Sweden, as about one new job in the mining sector produces almost one new job in other sectors in the region.

Regarding where the new jobs are created, in response to new jobs in the mining industry, the private services sector is particularly affected. The private services sector includes employment in retail trade, restaurants and hotels and the increase in employees in this sector is not surprising given that these sectors are local, and if income from employment increases in a region, the private services sector often benefits the most from people with more money to spend. This result is also interesting as it implies that the results from the recent mining boom in northern Sweden did not suffer from fly-in/fly-out effects, as a significant increase in the number of employees in Norrbotten is found.

Further, it is found that in the mining municipalities, the industrial sector also benefitted from growth in mining. This is also intuitive since the construction industry is heavily involved in work related to the large mining investments that have taken place in northern Sweden during the last decade. Another important conclusion to make is that there are relatively large inter-county differences between of the effects of mining in Norrbotten and Västerbotten. Mining has a stronger indirect impact on employment in Norrbotten than in Västerbotten county. The main explanation for this finding is given by important differences of the mining industries in the both counties. First, the mining industry in Norrbotten employs far more people compared to Västerbotten. Second, Norrbotten as a county is also to a larger extent specialized on mining. Third, iron ore dominates the mining industry in Norrbotten, and considering that it is a bulky product it increases infrastructure and logistics demands. It is thus possible that all of these differences contribute to the stronger employment impact of mining in Norrbotten compared to Västerbotten. Finally, in the long-run, technological progress will likely continue to reduce the number employees required to operate a mine, and thus also reduce the spill-over effects of mining on the local communities. It is therefore important that communities and regions dependent on mining diversify their economies, and perhaps seek strategies to create so-called mineral clusters which are better equipped to face the challenges faced by mining communities with too much dependence on only extraction.

SLOVAKIA, KOSICE

Current skills requirements

Employment in mining organizations recorded more or less decreasing trend of development, which connected logically with development of RM mining and using of technical and technological equipment during RM mining in Slovakia. During whole analyzed period higher employment had been recorded for employees, working at surface mining, which is again logically connected with prevailing surface way of RM exploitation in Slovakia. The highest employment had been recorded in 2000, when employment achieved level 13 968 employees (6 231 at deep mining and 7 737 at surface mining) and on the other hand the lowest level was achieved in 2016, when employment decreased to 5 476 employment (from which 1 666 in underground and 3 180 at surface mining. In following period total employment decreased to 45,5 % of employment in 2000 with average number of employees 8 273 employees.year^{-1}. In underground mining we recorded in analyzed period average employment - 3 169 employees.year^{-1} with its decrease in 2017 against 2000 by 62,3 % (which means 3 884 persons) from original employment. At the surface mining decrease of employment was rather smooth, when recording decrease by 48,2 % (which means

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3 731 persons) from original employment in 2000, while averagely at surface mining 5 105 employees/year had been employed (Fig. 6.3).

Considering employment development in Slovakia that was characterized by fluctuating tendency in 2000 – 2017 (Fig. 6.4.) and higher described employment development in mining sector, also the rate of mining sector recorded analogical trend of development, which means fluctuating tendency (Fig. 6.5). Average employment recorded in analyzed period in Slovakia 2 178 705 employees.year^{-1}, with the highest measure of employment in 2016 (2 390 000 employed) and with lowest measure in 2000 (2 024 848 employed), which in comparing with employment development in exploitation of raw material base means that average rate of mining on Slovakian employment achieved level 0,39% in analyzed period.

The highest rate of mining had been recorded in 2000, when 0,69% rate of mining had been achieved, which connected logically with the lowest level of employment in mining and on the other hand with the lowest employment in Slovakia. On the other hand the lowest rate in 2016 – level 0,22% resulted logically from the highest level of employment in Slovakia and the lowest employment in exploitation of raw material base. In general level the rate of mining on total employment of Slovakia was characterized by fluctuating tendency with decrease by 0,42% in 2017 against 2000 (Fig. 6.5).

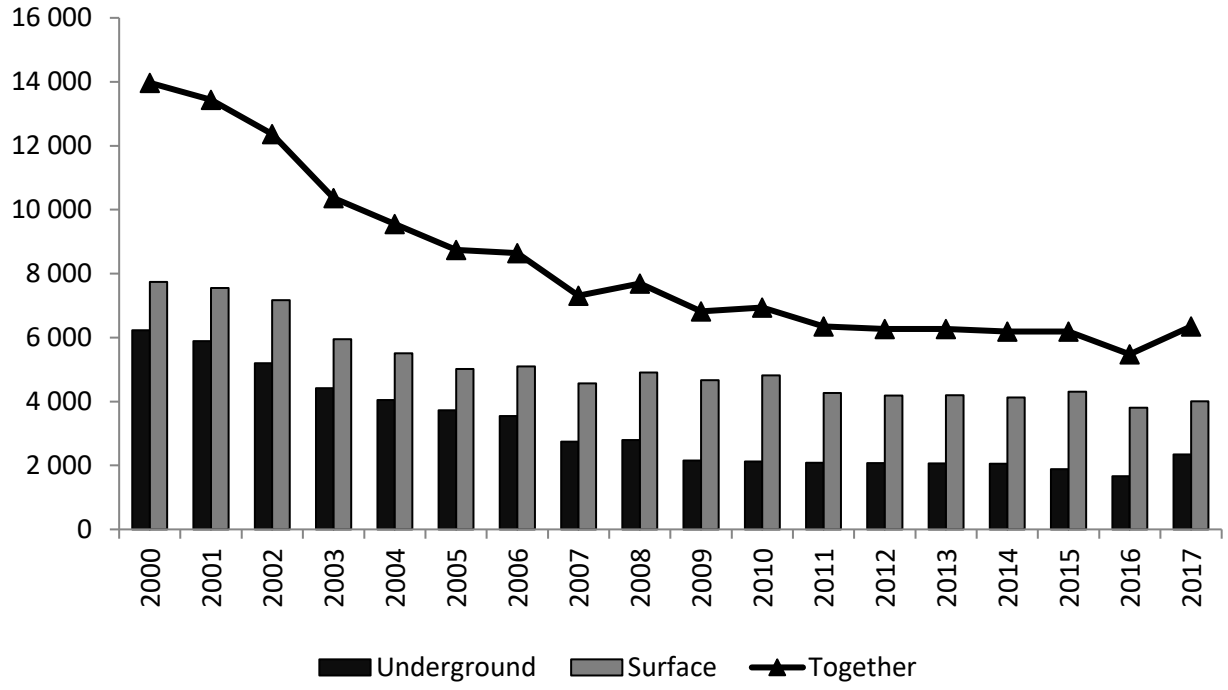

Fig. 6.3. Development of employment in mining organization of Slovakia. source: own study based on data from HBÚ SR

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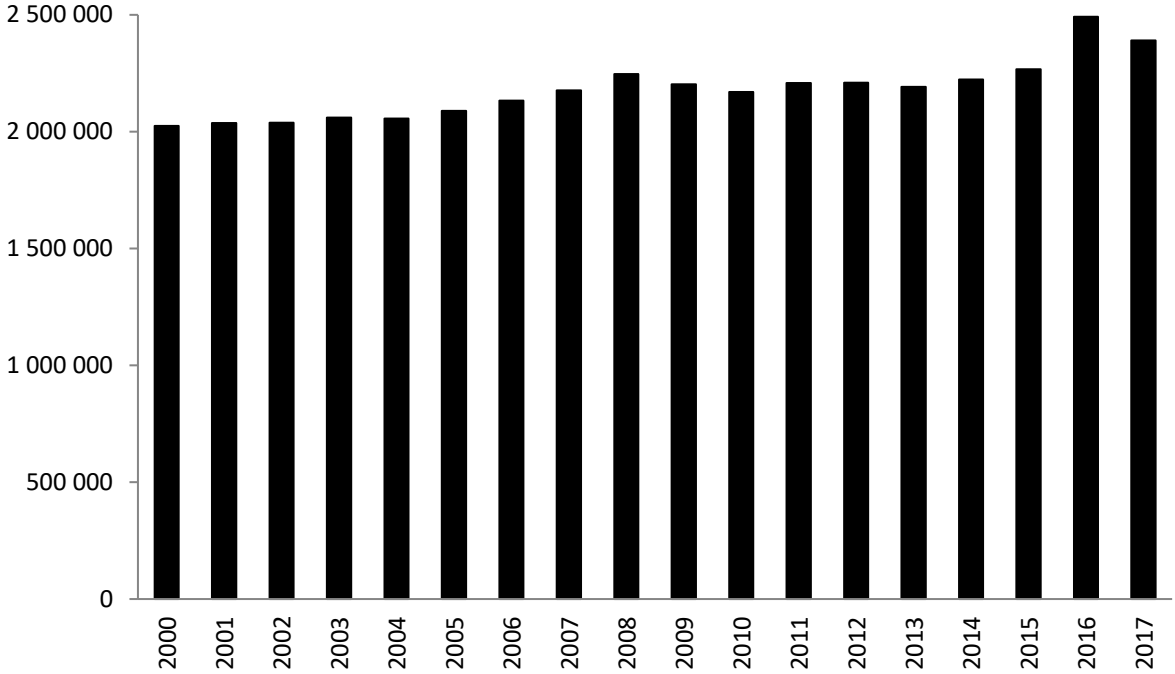

Fig. 6.4. Development of employment in Slovakia.
source: own study based on data from ŠÚ SR

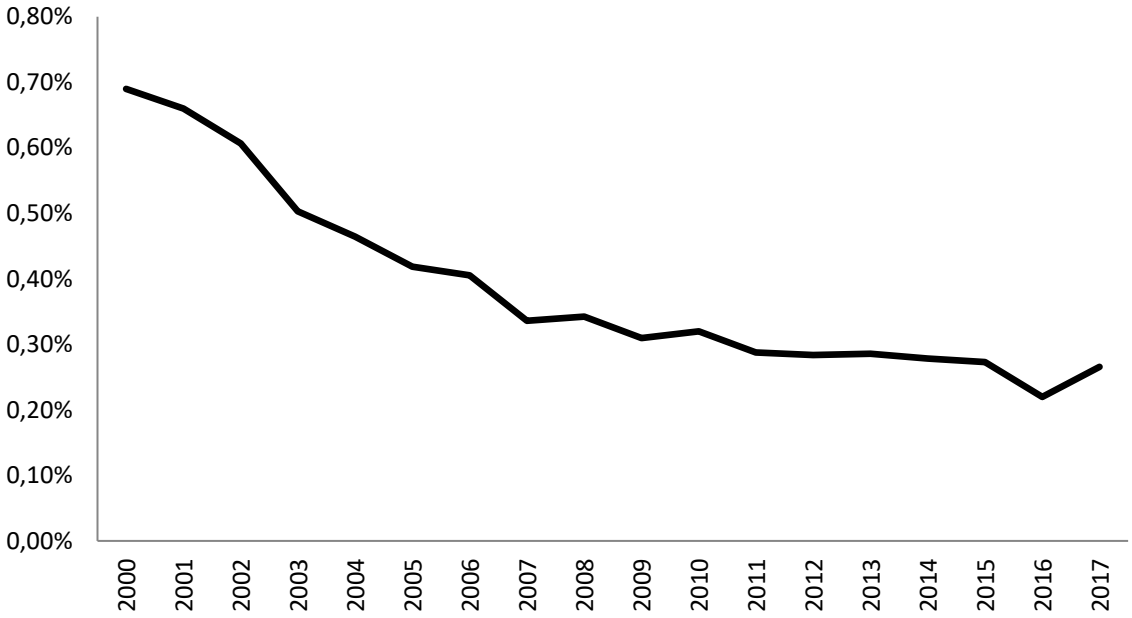

Fig. 6.5. Development of mining rate on employment of Slovakia.
source: own study based on data from ŠÚ SR and ŠGÚDŠ

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Future skills requirements

In Slovakia, the State Institute for Education analyzed the fields of study for the confrontation with the need of the labor market and their further direction.

The following status was found in the list of fields of study and fields of study with insufficient number of graduates for the needs of the labor market:

- geology, geotechnics and environmentalism,
- technician of mining operations.

Two new study departments have been approved for mining needs:

- geology, geotechnics and environmentalism,
- technician of mining operations.

From organizations associated in the Slovak mining chamber, the form of dual education for the 2016-2017 in Prievidza, a.s., in the disciplines:

- technician of mining operations, 15 students in total

According to the above mentioned foreseen for the horizon of the next 5 years it is strongly recommended to encourage study fields related to geology and mining in the strict sense of the word. Nevertheless it is important to emphasize that current trend within the high school graduates does not match with such needs. There is still lack of applicants especially for the geology.

GREECE, STEREA ELLADA

Current skills requirements

Figure 6.6. presents the total number of employees in mines and quarries for the Region of Sterea Ellada, divided in categories of employment, including the board of directors, scientists, and engineers, physical and non – physical workers. Apart from the employment rates of the total number of employees, the chart represents the participation of each gender, by category of employment.

It is noticeable that the majority of employees in mining and metallurgy industries for the region of Sterea Ellada are in the category of physical workers, numbering 952 employees. This category is about 11 times higher than the one of non - physical workers (the second higher percentage – 84 employees). The trend is the same observed for both genders, male and female workers.

Regarding the occupation of women in the mining and metallurgy industry, the employment percentages are lower compared to the percentages of men in the same sector, due to the fact that mining activity constitutes a sector of a low attractiveness for the female gender.

Figure 6.6 presents the number of employees for the year 2011, therefore there is the possibility that these data may have changed. The estimations show that due to more automation, new technologies and development of sciences, the nature of tasks for physical workers will change and new roles will be created requiring new sets of skills and capabilities (Ramdoo, 2018).

Besides the above-analyzed mining and metallurgy sector, another significant sector of occupation linked to mineral products, is manufacturing with the all the relative subsectors (presented in the table 6.5.). The subsectors of occupation constitute indicators for the current skills requirements of Sterea Ellada. In the region, there are processing and large industrial plants of mineral resources located mainly along the Thiva – Chalkida axis.

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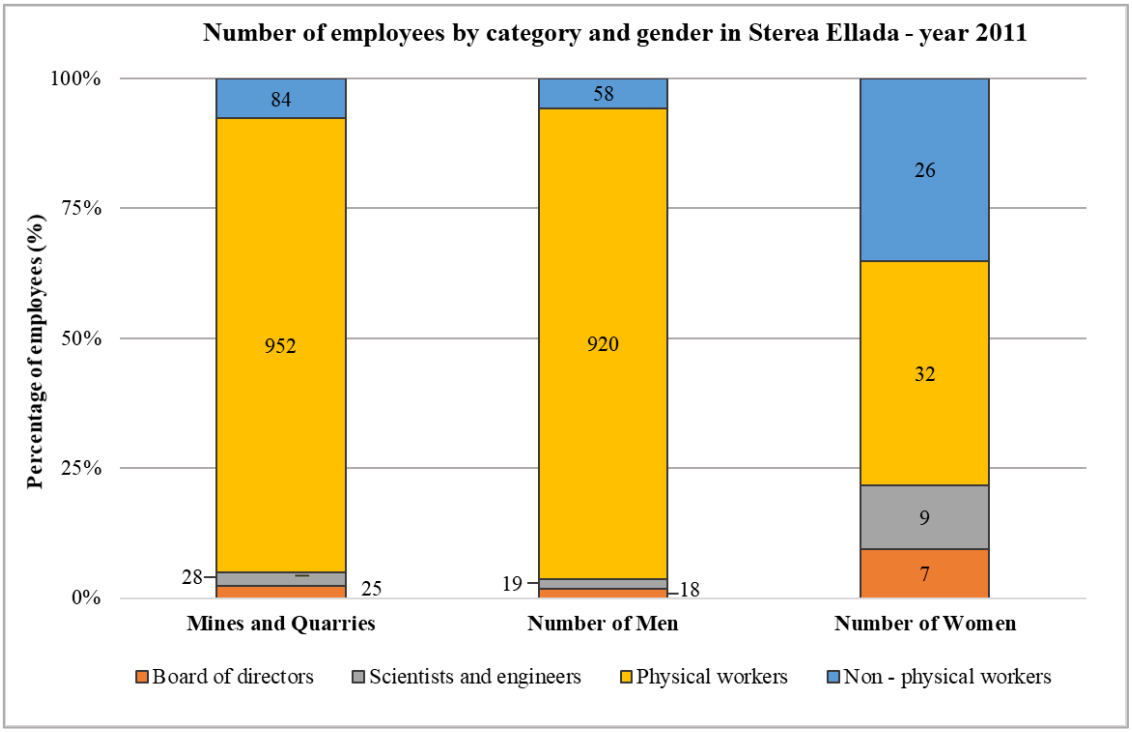

Fig. 6.6. Employment rates in Sterea Ellada, pursuant to the category of occupation in mines and quarries. Columns 2 and 3 present the statistics for each gender, in 2011.
source: own work on the basis of ELSTAT, 2011.

Table 6.5. Subsectors of Mining, Metallurgy and Manufacturing sectors. source: own work on the basis of ELSTAT, 2011

Mining & Quarrying	Manufacturing
Extraction of crude petroleum and natural gas	Manufacture of basic metals
Mining of metal ores	Manufacture of fabricated metal products, except machinery and equipment
Other mining and quarrying	Manufacture of electrical machinery and equipment
Mining support service activities	Manufacture of motor vehicles, trailers and semi-trailers

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Future skills requirements

According to the report of SEV about the demanding qualifications for the workforce, New Skills Agenda for Europe has singled out as general guidance the digital skills/digital learning, STEM skills[i], Green skills[ii], Basic and Soft qualifications as well as Entrepreneurship education (SEV, 2016). In the mining and metallurgy sector, technological advances shape the future of the sector while having an impact on the required skills: «Energy, mining Digital technologies and automation, have already begun to change the basic materials and energy industries (including mining, oil and gas, and utilities), enabling companies to tap into new reserves and increase extraction efficiency» (Bughin, 2018).

As a result, the advances in the above areas will play a role of paramount importance in the mining and metallurgy procedures. Through the usage of digital platforms and artificial intelligence applications, employees will have the opportunity to optimize equipment flow and failures, to manage the operations in real–time and to facilitate the extraction and production of the industry.

As for the mining Digital technologies, the requirements in mining and metallurgy sector includes Big Data Analytics, Geographic Information System (GIS) tools as well as PLCs (Programmable Logic Controllers). Specifically, employees have to deal with large and varied data sets (Big Data) and industries require detailed knowledge of geography, geology or spatial measurements, which could be made by the usage of Geographic Information Systems. Another future requirement of the mining and metallurgy sector could be the usage of Material Science on locating and analyzing deposits anytime and anywhere (SEV, 2019).

Regarding manual work, the use of new technologies remains a necessity and specifically, the use of autonomous technologies for the drilling procedures, the opening of tunnels as well as the handling of machines by distance and semi-autonomous crushers etc. are expected to grow significantly.

The forecasts on demanding qualifications require the employees to be aware of the above sectors, in order to advance the procedures of mining and metallurgy sectors. The continuous development of automation will impact the predictable manual work, which will be displaced. On the other hand, estimations predict an increase of technological jobs (software developers and computer systems analysts e.tc). In summary, it is estimated that the requirements for physical, manual and basic cognitive skills will decrease, while the demand for all other skills (related to higher cognitive and technological skills) should grow.

PORTUGAL, ALENTEJO

Current skills requirements

The present chapter is based on data collected on reports and websites from the largest company in the region: Somincor. Currently, Somincor employs 1,700 people (1000 employees and 700 contractors) (*Lundin Mining, 2017*). According to Figure 6.6 from 2006 to 2016, the number of employees in Somincor has been slightly increasing. Yet, for the same period, the number of contractors has shown more oscillations presenting a minimum in 2006 and a maximum in 2012 (Fig. 6.7).

Since the opening of the Neves-Corvo mine of the economic activity of the region has been altered. The mine has provided the emergence of new professions and the

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change in others. As a result, a profound change has occurred in the business sector of the region that, from being nearly monopolized by activities linked to the primary sector, became varied and extensive, with a growth potential based on the diversity of economic activities (LPN, 2016). The social impact caused by the volume of employment created (especially of specialized employment) led to a significant increase in people who came to work and reside either in Castro Verde or in areas adjacent to the mine (as Almodôvar and Ourique). Today, the mining activity represents 98% of the secondary sector's turnover and 30% of the active.

Given the size of the mine and the tonnage it produces, a large amount of human resources is required (Costa, 2017). In Somincor, geologists track the underground work of the mine daily and develop prospection and research work related to the calculation of Mineral Resources and Reserves (Costa, 2017). According to Lundin Mining sustainable report Neves-Corvo had in 2018 a total of 1089 full-time employees mostly permanent and male (Fig. 6.8).

Future – no recommendations

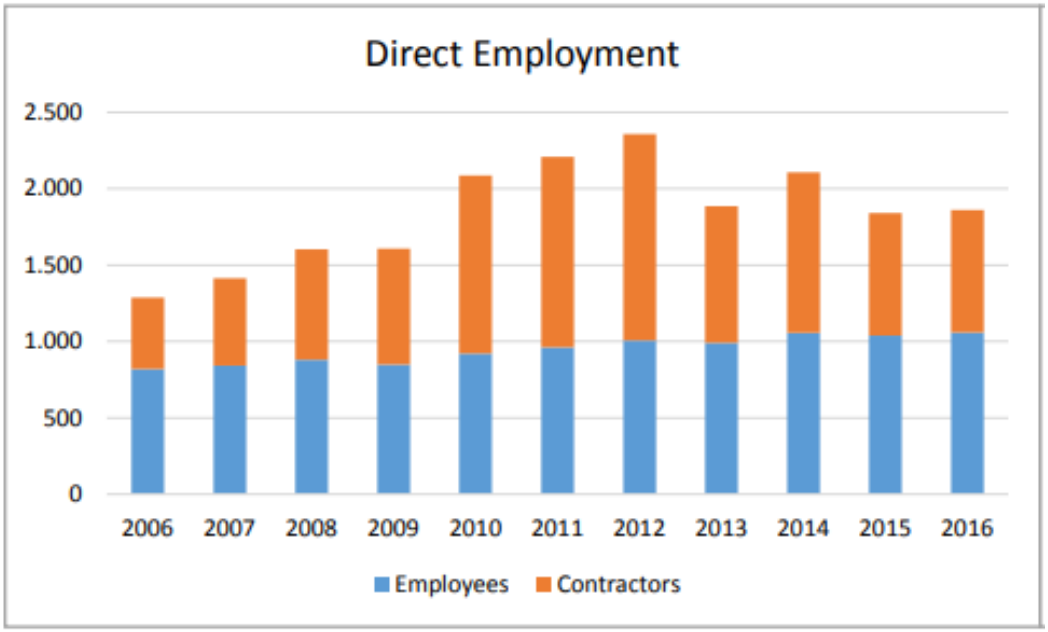

Fig. 6.7. Direct employment in Somincor (Lundin Mining, 2017)

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Neves-Corvo

	Male	Female	Total
Number of Employees	1,089	125	1,214
Permanent Employees	856	100	956
Temporary Employees	233	25	258
Full-time Employees	1,089	125	1,214
Part-time Employees	0	0	0
Other Workers*	924	87	1,011
Non-nationals/Expatriates	18	4	22
Employee Turnover (%)			4
Non-Managerial Workforce covered by collective bargaining agreements (%)			100

Figure 6.8. Staffing summary (Lundin Mining, 2018)

FINLAND

Current skills requirements

As the Finnish minerals sector is strongly growing, it is also facing a shortage of experts. Recently there has been discussion of the supply of skilled labour for mining industry. One of the main issues is the high age of the specialists and lack of young and middle aged professionals throughout the sector. This is due to recession in 1990s but also in early 2010s which affected also mining sector resulting in not only closing down the mines, but also lower training volumes and graduates. During the recession, the mining experts also moved working in other industry due to lack of work opportunities. (Lalli et al. 2005, Finnish Minerals Strategy 2010).

Lalli et al. 2005 estimated that opening a middle-sized mine would exhaust almost all skilled employees in Finland. E.g. in Sodankylä, there were sever recruiting challenges for skilled workforce for the Kevitsa mine and the shutdown of the vocational school worsened the situation. Although, mining education has increased since then, the growth of the mineral sector has been very rapid and there is not yet enough skilled personnel to fulfill the work force need in mining and metallurgy industry. The growing mining and prospecting activity will increase the need for skilled labour and there's a shortage especially of the lower degree experts.

The overall conclusion is that there is an urgent need for skilled personnel throughout the industry. According to the mining companies they are lacking especially the personnel working at the beginning of the process (e.g. drilling, blasting, and construction) as well as maintenance of the heavy machinery, but there is shortage on experienced personnel at every stage of the process. In terms of geology and excavation, there is urgent need for personnel with both knowledge on geology but also on economy. Whereas in mineral processing some of the work force shortage could be covered with chemical and processing engineers from other industries. (Pöllänen and Härkönen 2015).

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Future skills requirements

The Institute for economic research VATT forecasts at least 4 % growth in the requirements for miners (EDUFI 2011). In 2013 it was estimated that if all most promising mining projects would result in opening of a mine or expansion of the current mining operations, the workforce need in Lapland would be around 1000 persons, excluding exploration. In addition, according to questionnaire of FinnMin foundation in 2012, the estimated work force need for mining industry would be approx. 5600 persons by 2022, of which most would locate in Lapland (Pudas et al. 2013). Furthermore, Finnish mines are competing with Swedish and Norwegian mines regarding work force since Finnish mining experts especially with higher level degree get often employed by the Swedish or Norwegian mining companies due to higher salaries (Pyykkönen 2015).

The lack of skilled workforce is stated as a major thread for the mining sector also in the Finnish Mineral Strategy report (TEM 2018a). Although there is a need also for the lower degree personnel at mining industry, it will be the higher education personnel that is harder to get due to longer training times. Furthermore, the training can be carried out as on-job training and some of the experts can be also found from other industries and further trained for mining, such as processing and chemical engineers. Therefore, one of the proposed action is improving short and long-term planning of the mineral sector education. The aim is to reinforce the mining related teaching resources in universities and to develop specialized training programmes at universities of applied sciences, and lower degree technical trade schools. Especially the vocational training has been poorly coordinated across the sector, while training programmes in the sector have been reduced and teachers have retired. Therefore, the education of miner has started in several Education Institutions in Finland. The mining industry also demands a skilled professional workforce trained in modern mining techniques, which in turn requires appropriate, comprehensive training programmes in universities of applied sciences, technical colleges and trade schools (TEM 2018a).

7. CONCLUSION AND RECOMMENDATIONS

Current situation in mining and metallurgy industry in all researched regions Alentejo (Portugal), Košice (Slovakia), Lapland (Finland), Lower Silesia (Poland), Sterea Ellada (Greece), Norrbotten and Västerbotten (Sweden) with focus on – resources, prospective resources, existing steel plants and access to education were analysed in order to establish **set of recommendations** which will be comply with the EU Raw Materials Initiatives. Workshop on skills and requirements in the mining and metallurgy regions which was held in Cracow, Poland at 5-6 December, 2019 was also the basis for establishing recommendations.

1. Universities should provide lectures with aim to help students to be prepared for specific condition at the job market, providing development of demanded broad competences, which make it easy to be orientated at the foreign market.
2. At present, in most researched regions, the number of white collars employees (mining engineers included) is sufficient. By taking into consideration the emerging job offers, mining and metallurgical industry is mainly looking for a skilled blue collars employees. Unfortunately at this moment, it is observed that on the label market there is deficiency of people with hard set of skills (e.g. electrician, mechanics). **It is recommended to create the regional round**

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tables with representatives of vocational schools, industrial partners and universities in order to establish the cooperation towards the tailor skill education. Moreover, it is expected that almost in all researched countries there will be new mining investments, which will result in deficient of both white and blue collar employees. The regional round tables should establish: short-, middle- and long-term scenarios for mining and metallurgy activities in region with an emphasis on future demand on skills. Obtained information from the regional councils should be exchange with The European Network for Engineering Accreditation. This may create synergies and transfer knowledge between European mining and metallurgy regions, as well as, establish best practices in case of skills deficiencies on the label market.

3. There is a lack of cooperation between vocational schools, universities and industry or the cooperation is just formal (signed agreements but not so much real cooperation). It was established that there is usually an individual cooperation between specific university and industry or vocational school and industry. This result in none of the common curriculum which might developed a tailor set of skills. **The Finnish "Mine Specialisation Program" may be set up as a base in order to establish proper model of cooperation and training programs.**
4. According to the survey it was concluded that in most of cases mining or metallurgy company were responsible for gaining a practical skills of newly-graduates or other employees. **It was established that more long-time practical internships should be organised for students in order to gain new set of skills.** Moreover some activities form the teaching-factory model, like distance learning, interactive TV, online courses and time-tested tutoring, mentoring and lectures and involving students to provide services in designing and developing new solutions for industrial clients and complement their academic education with the hands on real engineering practice. Based on the knowledge triangle notion, this initiative would become a new paradigm of both academic and industrial learning, having in fact, a hybrid mission: engineering activities and improving both hard and soft skills of students and from the industrial site taking up research results and industrial learning activities for engineers for blue collar workers.
5. The social acceptance of mining and metallurgy activity is usually higher in regions where mining and metallurgical activity is ongoing. It was observed that in regions where mining or metallurgical activity doesn't have the biggest influence on regional budget, nor on employment ratio, social acceptance of expanding mining or metallurgical activity is lower.
6. With progressing automation and digitalisation of mining and metallurgy industry and upcoming Industrial Revolution 5.0 several aspects like skills shortages, fears of job losses or aspects related to organizational barriers, e.g. competitive thinking among departments and lacking communication should be studied among the mining and metallurgy employees. These insights will also be relevant from a managerial perspective.
7. It was concluded that there is a problem inside mining and metallurgy companies with a **communication** between specialist from different area of interests. In addition if we take into consideration the raising importance of social acceptance the necessity of soft skills is visible. **All companies should**

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perform the soft skills analysis in order to establish fields of improvement.

8. The availability of skilled labour for growing mining activities is important even from a general perspective, and it is important that the significance of the mining sector is consistently highlighted. Discussions held with educational institutions have indicated that the mining and metallurgy industry does not seem appealing to young people, due to uncertainties and the general image of the sector. Although the mining industry provides a multitude of different professions and work opportunities, the regional economy impacts are not always directly visible.
9. Regulatory and administrative body play great role in access to mineral deposits as well as efficient mining and metallurgical operations – they shape legislation and grant decisions which reflect their knowledge, skills and awareness or lack of them. In most analysed countries and regions they are elected this is why their education and skills in a specific field is irrelevant. However they operate with the help of offices (departments) of which education of their staff is important. According to the results only few have geological and mining education, even in municipal offices in which geological and mining activities are carried out.
10. The conclusions presented in point 9 allow to formulate the following **recommendation:** administrative bodies operating in mining regions/municipalities and included in the processes aimed at starting the mining activity (e.g. granting environmental decisions, concessions) should take part in mandatory trainings in the field of environmental, socio-economic and legal conditions of exploitation and manufacturing of mineral as well as in the scope of ”soft” skills that allow for better cooperation and communication.
11. It was concluded that the image of mining and metallurgy industry is not good among people. This result not only in low acceptance of mining or metallurgy activity but also in low attractiveness of the industry for potential new employees. **In order to improve the image, the new set of European programs should be established.** The new progams would focus on people’s integration with mining and metallurgy process, improvement of social awareness in subject of raw materials, sustainable development and products life cycle, as well as community development around mines.

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APPENDICES

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