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Trends in changes in competency expectations towards employees in the copper sector

Trendy zmian w oczekiwaniach kompetencyjnych względem pracowników sektora miedzi

Słowa kluczowe: kompetencje, luki kompetencyjne, górnictwo, miedź, foresight.

Streszczenie: Sektor wydobycia i przetwórstwa surowców (w tym miedzi) od wielu lat zmaga się z szeregiem wyzwań, w tym z koniecznością poprawy efektywności, zmniejszenia wpływu na środowisko naturalne, brakiem akceptacji społecznej i wreszcie – niewystarczająco wykwalifikowaną kadrą. Artykuł prezentuje wyniki badań desk research na temat oczekiwań kompetencyjnych względem aktualnych i przyszłych pracowników przemysłu miedziowego oraz badań typu foresight dotyczących prognozowanego zapotrzebowania na kompetencje w tym obszarze gospodarki do roku 2035. Przedstawiono wyniki i kluczowe wnioski dotyczące luk w umiejętnościach zaobserwowanych w sektorze Cu na terytoriach RIS (Regional Innovation Scheme). Analiz dokonano w ramach projektu „SkiComCu-Lifelong Learning Course for skills & competences in the Copper sector", finansowanego przez EIT RawMaterials (Umowa projektowa nr 23043). Wyniki badań zaprezentowano w formie zestawów umiejętności i kompetencji społecznych niezbędnych dla tego sektora, ze szczególnym uwzględnieniem wyzwań w zakresie jego innowacyjności (przemysł 4.0 i 5.0) oraz zielonej transformacji i gospodarki o obiegu zamkniętym. Wyniki badań foresight (metoda delficka, techniki backcasting i roadmapping) zaprezentowano w formie zintegrowanej prognozy przyszłych potrzeb kompetencyjnych dla całego łańcucha wartości miedzi.

Key words: competences, competence gaps, mining, copper, foresight.

Abstract: The raw materials mining and processing sectors (including copper) have been for many years struggling with a number of challenges, including the need to improve efficiency, decrease its impact on the natural environment, the lack of public acceptance and finally – insufficiently qualified personnel. This article presents the results of desk research on competency

expectations for the current and future employees in the copper industry, as well as foresight studies on the projected demand for competences in this area of the economy by 2035. It presents the results and key conclusions with regards to the skills gaps observed in the Cu-sector of RIS territories (Regional Innovation Scheme). The analyses were conducted within the project 'SkiComCu-Lifelong Learning Course for skills & competences in the Copper sector', financed by EIT RawMaterials (Project Agreement No. 23043) The research results were showcased as the sets of skills and social competences essential for this sector, with particular emphasis on challenges related to innovation (industries 4.0 & 5.0), clean transition, and the circular economy. The results of the foresight methods (Delphi method, backcasting and roadmapping techniques) were presented in the form of an integrated forecast of future competence needs for the whole copper value chain.

Introduction

The SkiComCu project[1]. is founded on the experience of past European Union projects which showed that there are a number of training options available worldwide for providing competences and skills, but none aimed at increasing the innovativeness of the RIS (Regional Innovation Scheme[2]) non-ferrous metal sector through the continuous updating of skills provision.

On the contrary, skills gaps are observed throughout this sector and this led the EU to include Action 6 (Develop expertise and skills in mining, extraction and processing technologies, as part of a balanced transition strategy in regions in transition from 2022 onwards) in its Critical Raw Materials Resilience strategy[3] and the new Critical Raw Materials Act 2024[4]. Secondly, one of the upcoming challenges that the copper industry has to face is labour transformation at the ages of Industry 4.0 and 5.0.

Securing reliable and unhindered access to raw materials is important for the European Union, where there are at least 30 million jobs depending on their availability. The copper sector, to which the SkiComCu project is dedicated, is an important subsector of the raw materials industry. Given the types of processes, it

1 https://skicomcu.eu/ (access: 27.12.2024).

2 The European Institute of Innovation and Technology (EIT) launched the EIT Regional Innovation Scheme in 2014 as its main tool for reducing Europe's regional innovation disparities; it helps innovators from eligible countries access EIT activities, creates links among regional innovation actors, and offers tailor-made programmes to support moderate and emerging innovating countries in building their innovation capacity, https://eit-ris.eu/about-eit-community/ (access: 10.12.2024).

3 Critical Raw Materials Resilience: Charting a Path towards greater Security and Sustainability; https://www.eesc.europa.eu/en/our-work/opinions-information-reports/opinions/critical-raw-materials-resilience-charting-path-towards-greater-security-and-sustainability (access: 10.12.2024).

4 Critical Raw Materials Act 2024: Regulation (EU) 2024/1252 of the European Parliament and of the Council of 11 April 2024 establishing a framework for ensuring a secure and sustainable supply of critical raw materials and amending Regulations (EU) No 168/2013, (EU) 2018/858, (EU) 2018/1724 and (EU) 2019/102; https://eur-lex.europa.eu/eli/reg/2024/1252/oj (access: 10.12.2024).

is most often understood comprehensively as a sector encompassing the following areas of activity (this is also the approach taken by the project SkiComCu):

- Copper exploration, including: collection, analysis, and integration of various thematic geoscientific data obtained from surface and subsurface exploration methods and techniques; Geological modelling, target generation, and estimation of resources;
- Mineral extraction and processing, including: exploitation of copper deposits using mining techniques; Mineral processing, including comminution, concentration and methods of separating commercially valuable minerals from their ores;
- Materials engineering and waste recycling, including: methods and processes of copper extraction from mineral concentrates and solutions, mechanical and chemical recycling processes to recover copper and minerals from waste (Fig. 1).

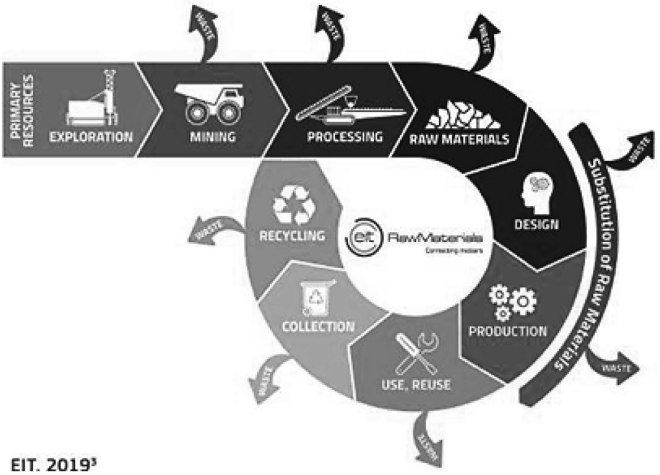

Fig. 1. Raw Materials Value Chain

Source: EIT Raw Materials Strategic Agenda, 2021–2027, p. 5.

The copper industry is moving towards circular, digital and climate-neutral activities, with sustainable development as a key factor. The wide deployment of automation and robotics, as well as the increasing hazardous environment of copper ore exploitation, are expected to create new job positions and new methods of working.

Specific skills and lifelong learning are then crucial for long-term sustainable growth and productivity. Providing people with the specific competences (according to the European Qualification Framework approach, competences consist of knowledge, skills and social competences) allows them to work more effectively and take advantage of innovative technologies, prevents labour market mismatches and lays the ground for research, development and firm-based innovation.

The main objective of the research part of the SkiComCu project was to to assess the training needs of selected groups of current and future employees in the Cu sector to ensure its competitiveness and to enable the sector to cope with its challenges.

Methodology

The methodological approach for the SkiComCu research works included a triangulation of these methods: 1) desk research, 2) on-line survey (for key competence profiles selected by project partnership as strategic for the future of the sector) and 3) participatory assessment – interviews with representatives of different groups of copper sector employees (Focus Groups Interviews). As a result, the Project Partnership proposed a catalogue of knowledge and skills which are currently needed by employees in the copper sector in various job positions (fully available when Deliverable 2.1 (Report on the assessment & validation of needs for Cu-oriented education chain selected groups) is published).

The desk research covered an extensive literature review, including scientific publications and industry reports (e.g. national and EU studies and analyses on the current state and future of the sector), but also relevant institutional documents related to Human Resources systems, provided, among others, by the industrial partners of the SkiComCu project: ElvalHalcor Hellenic Copper and Aluminium Industry S.A. (Greece), KGHM Polska Miedź S.A. (Poland) and Aurubis Bulgaria AD (Bulgaria). The objective of this first research step was to identify current occupations, skills and competences in the Cu sector and key competences for the future.

The methodological approach was also used to gain insights on the future of the copper sector towards the year 2035 by implementation of foresight-adapted tools (the Delphi method, backcasting and roadmapping). Foresight methods were used to map possible social and technical skills and competences needs that the copper sector workforce will require. The Delphi method, based on the quantitative and qualitative analyses of a series of statements and questions answered by experts, was used, together with backcasting and roadmapping techniques. Combination of these tools led to a better perception of the future state of the copper sector as well as its competences gaps.

Due to the extent and detail of the data obtained at the stage of online surveys and focus groups interviews, a separate publication will be devoted to the results of this research. In this article, the authors have focused on the results of desk research and foresight progonostic analysis.

Sector analyses and trends

European Commission's policy and strategy for raw materials shows that securing reliable and unhindered access to raw materials is crucial for the European Union, where copper recently became the critical raw material for Europe[5], and there are at

[5] European Commission. Critical raw materials; https://single-market-economy.ec.europa.eu/sectors/raw-materials/areas-specific-interest/critical-raw-materials_en (access: 10.12.2024).

least 30 million jobs depending on their availability[6]. According to the forecasts by the International Copper Association (ICA), copper is one of the raw materials for which demand continues to grow, also due to its application in energy generation, efficient buildings, and electrified transportation. Its physical properties make it a key material for many technologies enabling the transition to a climate-neutral economy: renewable energy generation, energy storage and efficient energy transfer, as well as electric cars or heat pumps. As an essential raw material for electronics, copper plays an important role in digital transformation. Very importantly, copper can be recycled repeatedly without losing its original properties. As a truly circular material facilitating the clean energy transition, copper contributes to Europe's resiliency by enabling open, strategic autonomy in the energy and raw materials sectors.

A study conducted by Ernst and Young shows that HR specialists in the copper sector underline the importance of changing staff recruitment and retention strategies and focusing on upskilling and retraining of existing employees (Ernst & Young, 2023). This is supported also by forecasts of the World Economic Forum, indicating higher investment in developing professional competences of existing employees and in retaining employees with special skills and qualifications, as talent availability when hiring will be much lower (WEF, 2023). Different training and education requirements hinder sometimes the free flow of workers from one region or industry to another.

This is driving countries to develop National Qualification Frameworks (NQFs) and attempt to relate them to the international system – European Qualification Framework (EQF). A qualifications framework is a formalized structure into which accredited qualifications are placed, allowing learners, training providers and employers to gain information about the broad equivalence of qualifications (UNESCO, 1984). Transparency and homogeneity about what people have learnt in order to obtain a qualification are crucial to ensuring that learners, training providers and employers give the appropriate economic, social and academic value to qualifications.

Available reports, academic data, industry studies indicate that the European labour market, including the mining and processing sector, is shaped by the interaction of four megatrends: technological progress, sustainable development, demographic change and globalization. But the deeper and more specific studies run by experts of the World Economic Forum have shown that the global trends that are most likely to transform the mining and metals industry include (Fig. 2):

- broader application of Environmental, Social and Governance (ESG) standards,
- greater localization of supply chains (process of sourcing materials, components, and services from local suppliers to meet the needs of a company),

[6] European Commission. Policy and strategy for raw materials; https://single-market-economy.ec.europa.eu/sectors/raw-materials/policy-and-strategy-raw-materials_en (access: 10.12.2024).

- climate-change induced investments into adapting operations,
- investments that facilitate the green transition of businesses.

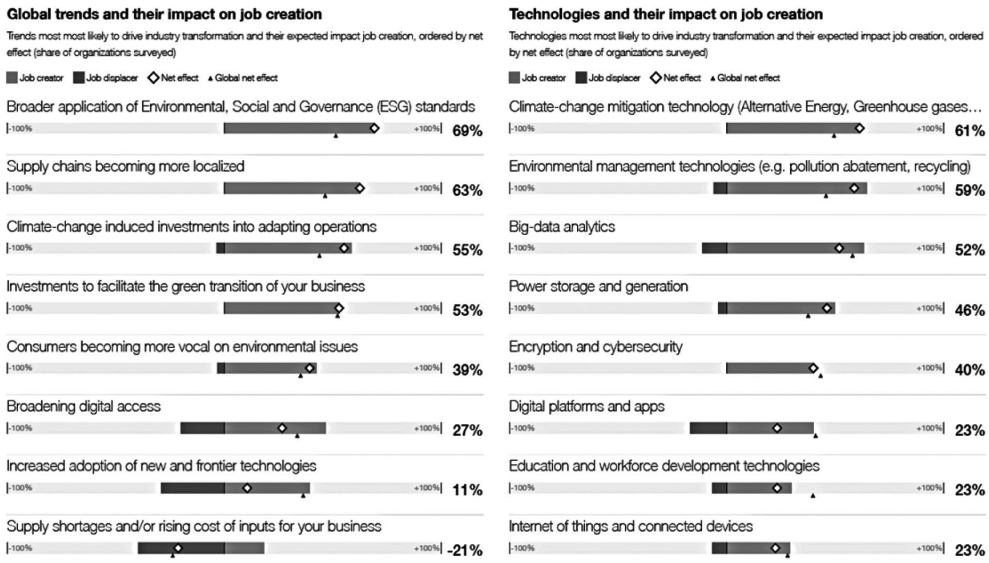

Fig. 2. Trend outlook for mining and metals sectors

Source: WEF, 2023, p. 221.

As result, technologies that will affect job creation and displacement will be adopted. They are:

- climate-change mitigation technologies (alternative energy, greenhouse gases),
- environmental management technologies (e.g. pollution abatement, recycling),
- big-data analytics (AI),
- power storage and generation,
- encryption and cybersecurity.

The most important changes in mining are improved safety, increased productivity, care for the environment and more efficient use of resources (Beloglazov et al., 2020). This reflects the aim of transformation towards Industry 4.0. It is based on the consolidation of systems and the integration of people with digitally controlled machines that make extensive use of the wireless network, information and communication technologies. The competences of the new Miner-Operator 4.0 will be directly related to automatization, digitization and interoperability (Lööw et al., 2019; Mackenzie, 2020; Ulewicz, 2022).

The raw materials mining and processing sectors (including copper), in many countries, have for many years been struggling with a problem of insufficiently qualified personnel (Fig. 3).

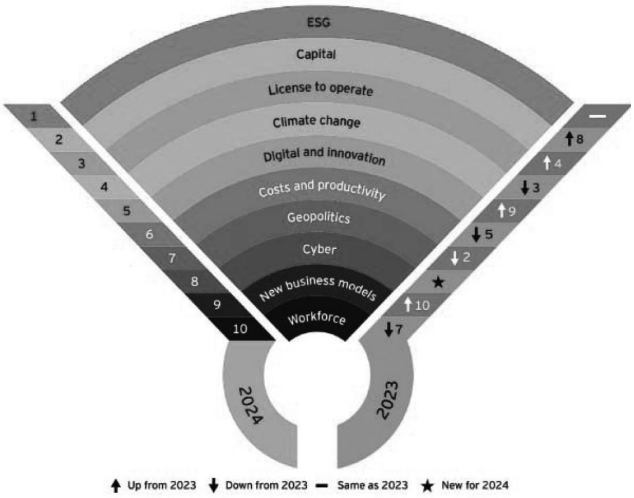

Fig. 3. Top 10 business risks and opportunities for the mining and metals sector in 2024
Source: Ernst & Young, 2023.

In an increasingly competitive labour market, the sector's poor brand ('dirty industry' responsible for significant environmental pollution) discourages workers, especially younger ones, who are far more attracted to energy transition-related undertakings. This results in serious demographic challenges for the sector, with an aging workforce.

Changing skills landscape

Simultaneously, the assumptions of the Industry 5.0 are becoming more and more evident, complementing the existing Industry 4.0 paradigm by highlighting research and innovation as drivers for a transition to a sustainable, human-centric and resilient European industry (Breque et al., 2021). According to the idea of the European Commission, the new vision of the industry should be strongly embedded in social, environmental and political contexts. Industry 5.0 focuses on energy-saving solutions, renewable energy sources and circular economy, which is confirmed by, among others, copper industry companies, who list these factors in the context of competence gaps and needs of the future staff competences (Deliverable 2.1). Introducing more innovative solutions to industrial processes (mining, processing, recycling) must go hand in hand with sustainable development and social needs (including the workforce), which will affect the optimization of decision-making processes, not just their acceleration.

A study commissioned by the Polish Development Fund and Google (Włoch, Śledziewska, 2020) shows that in the era of digitization and automation, competences that differentiate work done by humans from that carried out with

the use of or by information systems, robots or artificial intelligence, are becoming crucial, because in these areas, humans will still be difficult to replace. These competences are considered competences of the future. They are specific skills necessary to perform tasks in a work environment that is fundamentally flexible, geographically dispersed, prone to frequent and rapid change, assumes the need to use digital technologies and cooperate with automated systems and machines using artificial intelligence (Włoch R., Śledziewska K., 2020). They include cognitive, social, digital, and technical skills (Fig. 4).

Fig. 4. Competences of the future broken down into three skill groups

Source: Włoch R., Śledziewska K., 2020, p. 11.

Key expected skills and competences

McKinsey Global Institute (MGI) analysts assigned skills that are increasingly important in the labour market to the similar three groups:

- Technological and digital skills:
  - advanced (understanding of advanced technologies and ability to innovate, develop, and adapt them) – through 2030, time spent using advanced technological skills will increase by over 40% in Europe. People with these skills will inevitably be a minority and demand for advanced IT and programming skills will grow as much as 90%;

  - basic (ability to use digital technologies in everyday work, particularly in decision-making and information processing) – by 2030, demand for these skills will increase by 65%.
- Social skills: demand for social and emotional skills will grow across all industries by 22% in Europe. The rise in demand for entrepreneurship and initiative taking will be the fastest growing in this category, with a 32% rise.
- Higher cognitive skills: demand for higher cognitive skills, such as creativity, critical thinking, decision making, and complex information processing, will grow through 2030, by 14% in Europe. At the same time, basic data-input and processing skills will be particularly affected by automation, falling by 23%.

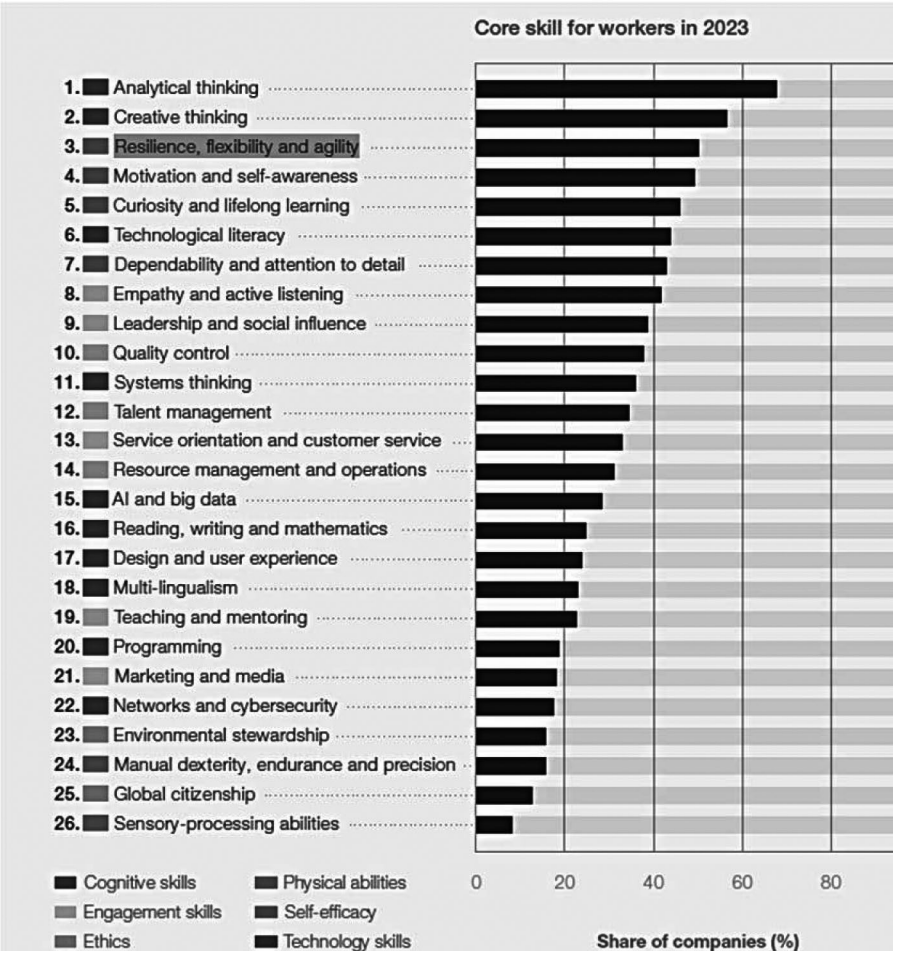

Fig. 5. Core skills in 2023

Source: WEF, 2023, p. 38.

Additionally, they also point out that in the era of rapid economic transformation (automation, digitization), it is worth associating competences with the development of certain attitudes, ways of thinking, learning and acting, rather than with specific learned skills only, which in the face of the aforementioned changes will be constantly changing (MGI, 2018). According to the WEF report (2023), analytical thinking and creative thinking remain the most important skills for workers (Fig. 5).

They are also among skills most prioritized for reskilling and upskilling in the next five years for mining and metals sector (Tab. 1).

Table 1. Skills crucial for business transformation in the mining and metals sector

Core skills needed to perform well in key, stable roles (%)	Skills most prioritized for reskilling and upskilling in the next five years (%)
Cognitive skills (22%) Engagement skills (6%) Management skills (17%) Physical abilities (4%) Technology skills (12%) Ethics (3%) Self-efficacy (22%) Working with others (15%)	Analytical thinking (54%) Leadership and social influence (46%) AI and big data (31%) Creative thinking (31%) Environmental stewardship (31%) Motivation and self-awareness (31%) Resilience, flexibility and agility understood as the power of moving quickly and easily (31%) Resource management and operations (31%) Talent management (31%) Technological literacy (31%)

Source: Own work based on WEF, 2023.

Taking into account all the data and information obtained through desk research, as well as its own experience, the Project Partnership proposes a catalogue of skills which are currently needed by employees in the copper sector in various job positions.

Competences needs in the future copper sector

Foresight methods were used to map possible social and technical skills and competences needs that the copper sector workforce will require towards 2035. The Delphi method, based on the quantitative and qualitative analysis of a series of statements and questions answered by experts, was used, together with backcasting and roadmapping techniques. Combination of these methods led to a better perception of the future state of the copper sector as well as its competences gaps.

The Delphi method for the SkiComCu project was implemented in three iterative rounds of statements and questions on the future state of the copper sector,

especially taking into consideration skills and competences needs and gaps. More than 45 copper sector experts from several countries across Europe and beyond, participated in the research. The first two rounds of the Delphi were dedicated to collect the future-demanded skills and competences for several job profiles. The third and final round was dedicated to obtaining a ranking on the importance of selected skills and competences.

Collected and ranked skills and competences were divided between four main areas covering the copper value chain: 1) Exploration, 2) Mining, 3) Processing and 4) Recycling. The results, for each of the four areas of the value chain, showed, in order of importance, the following technical and social needs for the workforce in 2035:

Exploration:

Technical: 3D and 4D modelling; Proficiency in remote sensing, satellite imagery and GIS software; Digital skills with on-ground exposure; Proficiency in advanced geophysical techniques; Big data and data handling, compilation and analysis; Knowledge of and capacity to use portable analytical equipment; Knowledge of environmental regulations; Artificial Intelligence and Machine Learning; Safe operation of equipment; Use of IT intensive techniques; Safe working practices.

Social: Communication with stakeholders, negotiation skills and community relations; Problem solving and decision-making; Ability to communicate effectively; Cooperation and teamwork; Open mindedness; Flexibility; Resilience in harsh environments; Multitasking; Reporting; Knowledge in two or more languages and Work in multicountry environments; Initiative; Administration and Project Management.

Mining:

Technical: Health and Safety; Knowledge of deep mining; Automation and remote control technology; Safe operation and maintenance of autonomous and robotic equipment; Knowledge of tailings management; Ability to integrate new solutions in existing systems; Digital skills with on-ground exposure; Use of artificial intelligence and machine learning tools; Knowledge of digital twins; Big data and data handling, compilation and analysis; Knowledge of extractive metallurgy; Knowledge in and application of energy efficiency & energy savings processes; Fleet management; Installing, operating and manufacturing advanced extraction technologies.

Social: Ability to communicate effectively; Communication with stakeholders, negotiation skills and community relations; Cooperation and teamwork; Leadership and management; Performing under stress; Resilience in harsh environments; Problem solving and decision-making; Open mindedness; Knowledge in two or more languages and work in multicountry environments; Reporting; Risk assessment; Multitasking; Flexibility.

Processing:

Technical: Safe operation of equipment; Knowledge of physical metallurgy; Knowledge of hydro-pyrometallurgy; Knowledge and application of Health and Safety protocols; Modern processing ideas, Knowledge of energy efficiency and energy recovery processes; Data handling, compilation and analysis; Digital skills; Use of robotics, remote control and automation tools; Use of Artificial Intelligence and Machine Learning tools; Ability to integrate new solutions in existing systems.

Social: Problem solving and decision-making; Open mindedness; Being innovative and having knowledge on innovation processes; Communication; Adaptability and flexibility; Cooperation and teamwork; Result orientation; Leadership and management; Reporting; Knowledge in two or more languages and work in multicountry environments; Multitasking; Resilience in harsh environments.

Recycling:

Technical: Knowledge and application of circular economy concepts; Knowledge and application of Health and Safety protocols; Knowledge of energy efficiency and energy recovery processes; Safe operation of equipment; Quality control; Data handling, compilation and analysis; Use of robotics, remote control and automation tools; Knowledge of urban mining; Knowledge of physical metallurgy.

Social: Responsibility; Problem solving and decision-making; Communication; Cooperation and teamwork; Flexibility; Leadership and management; Multitasking, Reporting, Focus and stamina.

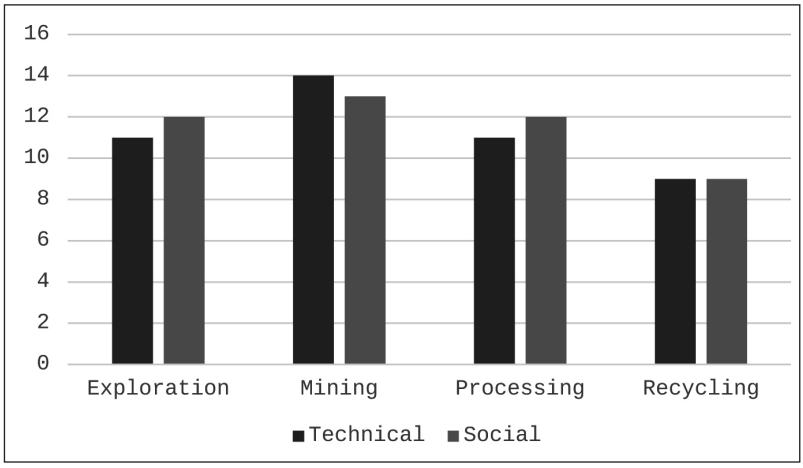

Fig. 6. Competences needs in the copper sector in 2035

Source: Own work based on results of foresight research.

Results demonstrate a good balance between the future need of technical and social-related skills in competences for the copper sector, in line with the trend of

the growing importance of social competences necessary to perform several jobs and tasks (Fig. 6). In general, the number of in-demand social-related competences in 2035 will be higher than the technical counterparts for Exploration and Processing jobs, while it will be lower for Mining and equal for Recycling jobs. Despite these small differences, all parts of the value chain will present very approximate division of technical and social skills and competences needs (Deliverable 2.3 – SkiComCu long term action plan and 10-year foresight report).

Skills and competences gaps identified for 2035 are aligned with the trends for the copper sector and are a direct adaptation to the needs created by drivers of change. These trends and drivers focus on technological changes, coupling of social and technical skills and competences, decarbonisation of operations and circular economy, appearance and normalization of new tactics and processes in operations, higher importance given to Environmental, Social, and Governance, as well as sustainability. For all parts of the value chain, there will be a lack of workforce capable of using new techniques and methods, since these require specific technical skills and competences.

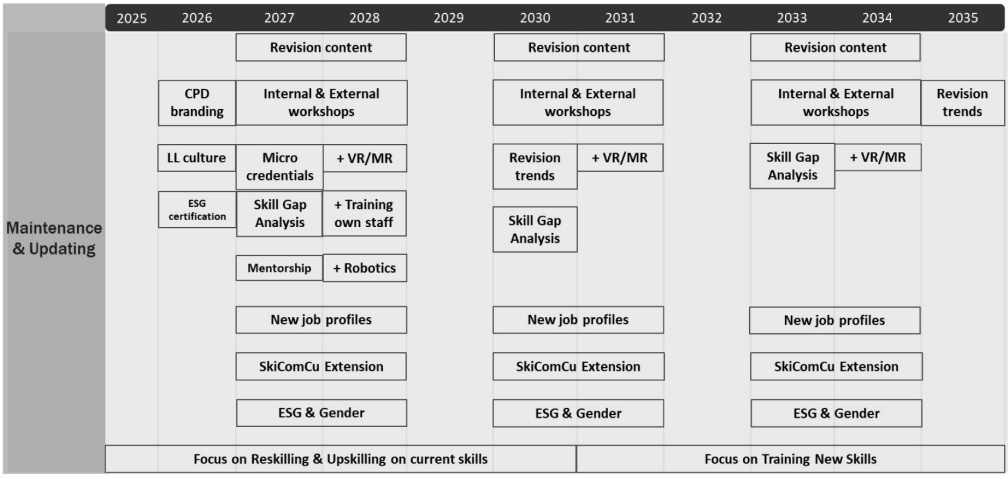

Fig. 7. Roadmap presenting actions and timeline for the SkiComCu platform and training

Source: Deliverable 2.3.

The adaptation of the copper sector to the trends and drivers of change will lead to changes in the copper sector jobs profiles. It was found that key job profiles for 2035 might include, among others, Sustainability and Environmental Managers, Automation and Robotics Engineers, AI and Machine Learning Specialists, Renewable Energy Integration Specialists, Circular Economy Experts, Remote Operations Managers, Health and Safety Coordinators, Technologists in copper recycling (as well as in battery recycling processes), Physical metallurgists, Pyrometallurgists, Hydrometallurgists, and Specialists in logistics.

To contribute to solving the skills and competences gaps in the copper sector, the SkiComCu project team created a roadmap with actions and timelines for the future implementation and development of its platform, which is currently in development (Fig. 7.). The actions listed in the roadmap are dedicated to guaranteeing that the platform stays up to date with trends, addressing skills and competences that are most relevant for a specific timeframe.

Conclusions

Analysing the collected source materials and the selected and presented data b, it is possible to indicate some of the most important observations and conclusions:

1. Megatrends shaping labour market (incl. Cu sector) are: technological progress, sustainable development, demographic change.
2. Global trends that are most likely to transform the mining and metal industry are the following:
   - broader application of Environmental, Social and Governance (ESG) standards,
   - greater localization of supply chains,
   - climate-change induced investments into adapting operations,
   - investments that facilitate the green transition of businesses.
3. In terms of technological changes that affect the competence requirements of current and future employees in the copper sector, these will be related to automation and digitalisation processes, including:
   - remote control of most activities,
   - reducing the risk associated with the human-machine interface by implementing modern robotics and autonomous device solutions,
   - virtual and augmented reality (VR, AR) applications,
   - real-time monitoring and analysis of production through scanning, monitoring, and real-time decision-making based on incoming data.
4. Skills that are increasingly important for the future of employees, who have to adapt to the changing situation in companies undergoing dynamic processes of transformation can be grouped into the following three categories:
   - technological and digital skills (understanding of advanced technologies and ability to innovate, develop, and adapt them),
   - social skills (e.g. entrepreneurship, initiative taking, cooperation with others),
   - higher cognitive skills (e.g. creativity, critical thinking, decision making, complex information processing, solving complex problems).
5. Core competences for the copper sector (connecting skills specific for the raw materials sector with professional and personal skills) should include:
   - the ability to communicate clearly verbally and in writing,
   - mathematical, scientific, and technological skills,
   - general understanding of sustainability as well as energy and materials efficiency,
   - general understanding of the raw materials (copper) value chain,
   - knowledge and understanding of geological processes,

- digital skills,
- knowledge of and commitment to safe working practices.

6. Among the skills crucial for business transformation in the mining and metals sector, following are indicated as needed for reskilling and upskilling in the next five years:
   - analytical thinking,
   - leadership and social influence,
   - creative thinking,
   - AI and big data,
   - environmental stewardship,
   - motivation and self-awareness,
   - resilience, flexibility and agility understood as the power of moving quickly and easily,
   - resource management and operations,
   - talent management,
   - technological literacy.
7. The copper sector towards 2035 will see some of the currently identified trends becoming reality and that will lead to a partially-changed sector dictated by high use of technology throughout the value chain supported by the use of Artificial Intelligence, Machine Learning, Virtual and Augmented Reality, remote and autonomous machines, which in turn, will reflect the appearance of new job profiles dedicated to addressing the use of these tools.
8. Stakeholders throughout the value chain will be more integrated into the different steps of exploration, mining, processing and recycling – with different levels of new technology and techniques implementation – contributing to the sector's Social Licence to Operate (SLO) and ESG values, which will only grow in importance. For training of workforce for the sector, standardization of training content and a system of microcredentials for workers will be leveraged. It is expected that upskilling of current workforce becomes a norm. Inherent to these changes and adaptations are also the changes in skills and competences for professionals, resulting in considerable skill shortages, arising from the implementation of new technological approaches, and leading to problems with the workforce.

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